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Indian Standard

GUIDE FOR REQUIREMENTS AND TESTING OF ELECTRIC STOVES

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CONTENTS

PAGE

FOREWORD 1
1 SCOPE 2
2 TERMINOLOGY 2
3 GENERAL REQUIREMENT 5
4 GENERAL NOTES ON TESTS 5
5 RATING 5
6 MARKING 5
7 PROTECTION AGAINST ELECTRIC SHOCK 6
8 INPUT AND CURRENT 7
9 TEMPERATURE-RISE 7
10 OPERATION UNDER OVERLOAD CONDITIONS 8
11 ELECTRICAL INSULATION AND LEAKAGE CURRENT AT OPERATING TEMPERATURE 8
12 MOISTURE RESISTANCE 9
13 INSULATION RESISTANCE AND ELECTRIC STRENGTH (AFTER HUMIDITY TREATMENT) 10
14 ENDURANCE 10
15 ABNORMAL OPERATION 11
16 STABILITY AND MECHANICAL HAZARDS 11
17 MECHANICAL STRENGTH 11
18 CONSTRUCTION 13
19 INTERNAL WIRING 14
20 COMPONENTS 15
21 SUPPLY CONNECTIONS AND EXTERNAL FLEXIBLE CABLE AND CORD ... 15
22 TERMINALS FOR EXTERNAL CONDUCTORS 17
23 PROVISION FOR EARTHING 19
24 SCREWS AND CONNECTIONS 20
25 CREEPAGE DISTANCES AND CLEARANCES 21
26 RESISTANCE TO HEAT, FIRE AND TRACKING 21
27 RESISTANCE TO RUSTING 23
28 FINISH 24
29 THERMAL EFFICIENCY 24

ANNEXES

ANNEX A CATEGORIES OF TESTS 25
ANNEX B LIST OF TEST EQUIPMENT FOR ELECTRIC STOVES 26
ANNEX C MEASUREMENT OF TEMPERATURE 27
ANNEX D IMPACT TEST APPARATUS 28
ANNEX E THERMAL CONTROLS AND OVERLOAD RELEASES 28
ANNEX F MEASUREMENT OF CREEPAGE DISTANCES AND CLEARANCES ... 29
ANNEX G TEST FOR FIRE-RESISTING PROPERTIES 31
ANNEX H SAMPLING PROCEDURE FOR ACCEPTANCE TESTS 33

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GUIDE FOR REQUIREMENTS AND TESTING OF ELECTRIC STOVES

FOREWORD

Presently the general requirements and related methods of tests of electrical appliances are covered in IS 302 : 1979 'General and safety requirements for household and similar electrical appliances (*fifth revision*)' while individual appliances are covered in series of standards which make reference to IS 302 : 1979, as applicable. The small scale industry has expressed the need for a comprehensive special document to cover all details in one publication, even at the cost of repetition, for particular appliances such as electric irons, electric immersion water heaters, electric stoves and electric radiators so as to facilitate easy references for use of Indian Standards at the shop floor level. This special publication is prepared to meet this demand and covers electric stoves designed for connection to single phase supply voltage up to 250 V ac or dc.

The requirements of electrically heated stoves are covered in IS 2994 : 1986 'Electric stoves (*first revision*)'. In case of any deviations between the requirements of this guide and those specified in IS 2994 : 1986, the provisions of the latter shall prevail.

The following presumptions have been made in this guide :

a) Electrically heated stoves are assembled from :

   i) *open heating element(s)* — made from resistance heating wire placed in porcelain grooved plates and two ends terminals for connection,

   ii) *body* — made of metal or non-ignitable material having provision for fixing heating plate and hob for placing vessel for heating purpose,

   iii) *safety guard* — made from wire to prevent accidental contact with glowing heating element and live parts,

   iv) three cores tough rubber sheathed cable with or without appliance connector and a three pin plug for connection to supply, and

   v) optionally, stoves may be designed to provide protection against abnormal operation by use of thermal cut-out, temperature limiter or thermostat.

b) The electric stoves have metal parts separated from live parts by basic insulation which are exposed to the touch by the user. Such construction is classified as Class I and it shall have provision for earthing.

c) The power supply cord may be attached to the electric stoves in such a way that its replacement is possible with any or special lead (cable) without the use of special tools. Such attachments, classified as Type X or Type M, are considered in this guide.

   Alternatively the electric stove may be provided with an appliance inlet for accommodating supply lead connector.

The following Indian Standards have been taken into consideration while preparing this guide :

IS 302 : 1979	General and safety requirements for household and similar electrical appliances (*fifth revision*)
IS 2994 : 1986	Specification for electric stoves (*first revision*)

Elsewhere in this guide, the reference to the following Indian Standards has been made and these may be used for detailed information :

IS 513 : 1986	Cold rolled low carbon sheet and strips (*third revision*)
IS 722 (Part 8) : 1972	AC electricity meters : Part 8 Single-phase 2-wire whole current watt-hour meters (class 1.0)
IS 1248 (Part 1) : 1983	Direct acting indicating analogue electrical measuring instrument and their accessories : Part 1 General requirements
IS 1248 (Part 2) : 1983	Direct acting indicating analogue electrical measuring instrument and their accessories : Part 2 Ammeters and voltmeters
IS 1248 (Part 3) : 1983	Direct acting indicating analogue electrical measuring instrument and their accessories : Part 3 Wattmeters and varmeters
IS 1293 : 1988	Plugs and sockets outlets of 250 V and rated current 16 amperes
IS 1401 : 1970	Accessibility tests probes (*first revision*)
IS 2053 : 1974	Thermocouple pyrometers (*first revision*)
IS 3010 (Parts 1 & 2) : 1965	Appliance connectors, appliance inlets (Non-reversible three-pin type)

IS 3389 : 1965	Urea formaldehyde moulding materials
IS 3725 : 1966	Resistance wire, tapes and strips for heating elements
IS 3854 : 1988	Switches for domestic and similar purposes
IS 4905 : 1968	Methods for random sampling
IS 9968 (Part 1) : 1988	Elastomer insulated cables: Part 1 For working voltages up to and including 1 100 V

For the purpose of deciding whether a particular requirement of this guide is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1 SCOPE

1.1 This guide covers the general, safety and performance requirements as well as procedures to conduct tests on ac or dc single phase portable type electric stoves rated up to 250 V and intended for heating liquids or cooking food. This guide applies to Class I appliances with either supply lead attachment of Type X or Type M or an appliance inlet.

NOTE — For proper understanding, wherever in this guide the word 'appliance' appears, it means an 'electric stove'.

1.2 This guide does not cover the electric hot plates and multi unit type electric stoves having more than one heating unit.

2 TERMINOLOGY

2.0 For the purpose of this guide, the following definitions shall apply. Where the terms voltage and current are used, they imply the rms values, unless otherwise specified.

2.1 Electric Stove

An electric appliance containing open type heating element, designed to accommodate, on its upper surface, a vessel for heating liquids or cooking food.

2.2 Safety Guard

Is a part which prevents accidental contact with live parts or moving parts of an appliance.

2.3 Rated Voltage

The voltage (for three-phase supply, the voltage between phases) assigned to the appliance by the manufacturer.

2.4 Rated Voltage Range

The voltage range assigned to the appliance by the manufacturer, expressed by its lower and upper limits.

2.5 Working Voltage

The maximum voltage to which the part under consideration can be subjected when the appliance is operating at its rated voltage and under normal conditions of use.

NOTES

1 Normal conditions of use include changes of voltage within the appliance imposed by likely occurrences such as the operation of a circuit-breaker or the failure of a lamp.

2 When deducing the working voltage, the effect of possible transient voltages on the supply mains is ignored.

2.6 Rated Input

The input under conditions of adequate heat discharge or under normal load and at normal operating temperature, assigned to the appliance by the manufacturer.

2.7 Rated Frequency

The frequency assigned to the appliance by the manufacturer.

2.8 Detachable Flexible Cable or Cord

A flexible cable or cord, for supply or other purposes, intended to be connected to the appliance by means of a suitable appliance coupler.

2.9 Power Supply Cord

A flexible cable or cord, for supply purposes, fixed to, or assembled with the appliance according to one of the following methods:

a) Type X attachment which denotes a method of attachment such that the flexible cable or cord can easily be replaced, without the aid of special purpose tools, by a flexible cable or cord not requiring any special preparation.

b) Type M attachment which denotes a method of attachment such that the flexible cable or cord can easily be replaced, without the aid of special purpose tools, by a special cable or cord with, for example, a moulded-on cord guard or crimped terminations.

2.10 Supply Leads

A set of wires connected to the appliance in the factory, intended for the connection to fixed wiring and accommodated in a special junction box or compartment within, or attached to the appliance.

2.11 Basic Insulation

An insulation applied to live parts to provide basic protection against electric shock.

NOTES

1 Basic insulation does not necessarily include insulation used exclusively for functional purposes.

2 The insulating properties of lacquer, enamel, ordinary paper, cotton, oxide film on metal parts, beads and sealing compound shall not be relied upon to give the required protection against accidental contact with live parts.

2.12 Supplementary Insulation

An independent insulation applied in addition to the basic insulation, in order to ensure protection against electric shock in event of a failure of the basic insulation.

2.13 Class I Appliance

An appliance in which protection against electric shock does not rely on basic insulation only, but which includes an additional safety precaution in that accessible conductive parts are connected to the protective earthing conductor in the fixed wiring of the installation, in such a way that accessible conductive parts cannot become live in the event of a failure of the basic insulation.

NOTES

1 Class I appliances may have parts with double insulation or reinforced insulation, or parts operating at safety extra-low voltage.

2 For appliances intended for use with a flexible cord or cable, this provision includes a protective conductor as part of the flexible cord or cable.

2.14 Low Voltage

A voltage not exceeding 250 V under normal conditions.

2.15 Medium Voltage

A voltage exceeding 250 V but not exceeding 650 V under normal conditions.

2.16 Safety Extra-Low Voltage

A nominal voltage not exceeding 32 V between conductors and between conductors and earth or, for three-phase supply, not exceeding 18.5 V between conductors and neutral, the no-load voltage not exceeding 38 V and 22 V, respectively.

NOTES

1 When safety extra-low voltage is obtained from the supply mains, it must be through a safety isolating transformer or a convertor with separate windings.

2 The voltage limits specified are based on the assumption that the safety isolating transformer is operated at its rated supply voltage.

2.17 Safety Isolating Transformer

A transformer, the input winding of which is electrically separated from the output windings by an insulation at least equivalent to double insulation or reinforced insulation, and which is designed to supply a distribution circuit, an appliance or other equipment at safety extra-low voltage.

2.18 Portable Appliance

Either an appliance which is moved while in operation or an appliance which can easily be moved from one place to another while connected to the supply.

2.19 Continuous Operation

Operation under normal load or under adequate heat discharge for an unlimited period.

2.20 Conditions of Adequate Heat Discharge

The condition of adequate heat discharge denote that the electric stove is operated under the following condition :

A pan shall be positioned centrally over the heating surface and it shall have sufficient area to cover the heating surface. The dimensions of the pan shall not exceed the dimensions of the heating surface by more than 10 mm. The pan shall be of normal, not brightly polished aluminium, the bottom surface being flat to within 0.05 mm.

The capacity of the pan shall be 3.0 litres per kilowatt rating and it shall contain 1.5 litres per kilowatt of initially cold water, evaporation losses being made up as necessary. The test vessel should be covered by a well fitting lid.

2.21 Non-Detachable Part

A part which can only be removed with the aid of a tool.

2.22 Detachable Part

A part which can be removed without the aid of a tool, except specified otherwise in the text.

2.23 Thermostat

A temperature-sensing device, the operating temperature of which may be either fixed or adjustable and which, during normal operation, keeps the temperature of an appliance, or of parts of it, between certain limits by automatically opening and closing a circuit.

2.24 Temperature Limiter

A temperature-sensing device, the operating temperature of which may be either fixed or adjustable and which, during normal operation, operates by opening or closing a circuit when the temperature of an appliance, or of parts of it, reaches a predetermined value.

NOTE — It does not make the reverse operation during the normal duty cycle of the appliance. It may or may not require manual resetting.

2.25 Thermal Cut-Out

A device which, during abnormal operation, limits the temperature of an appliance, or of parts of it, by automatically opening the circuit or by reducing the current, and which is so constructed that its setting cannot be altered by the user.

2.26 Non-Self Resetting Thermal Cut-Out

A thermal cut-out which requires resetting by hand, or replacement of a part, in order to restore the current.

2.27 Tool

A screwdriver, a coin or any other object which may be used to operate a screw or similar fixing means.

2.28 Creepage Distance

The shortest path between two conductive parts, or between a conductive part and the bounding surface of the appliance, measured along the surface of the insulating material.

2.29 Clearance

The shortest distance between two conductive parts, or between a conductive part and the bounding surface of the appliance, measured through air.

NOTE — The bounding surface of the appliance is the outer surface of the enclosure, considered as though metal foil were pressed into contact with accessible surfaces of insulating material.

2.30 All-Pole Disconnection

For single-phase ac appliances and for dc appliances, disconnection of both supply conductors by a single switching action or, for appliances to be connected to more than two supply conductors, disconnection of all supply conductors, except the earthed (grounded) conductor, by a single switching action.

NOTE — The protective earthing conductor is not considered to be a supply conductor.

2.31 Accessible Parts or Accessible Surface

A live part or *a live* surface which can be touched by means of the standard test finger shown in Fig. 1.

2.32 Body

The term includes all accessible metal parts, grips and the like and metal foil in contact with all accessible surfaces of insulating material; it does not include inaccessible metal parts.

2.33 Steady State Condition

The steady state condition is considered to have been reached when the difference between two consecutive readings of temperature-rise over the ambient taken at half an hour interval has not exceeded 1°C.

2.34 Type Tests

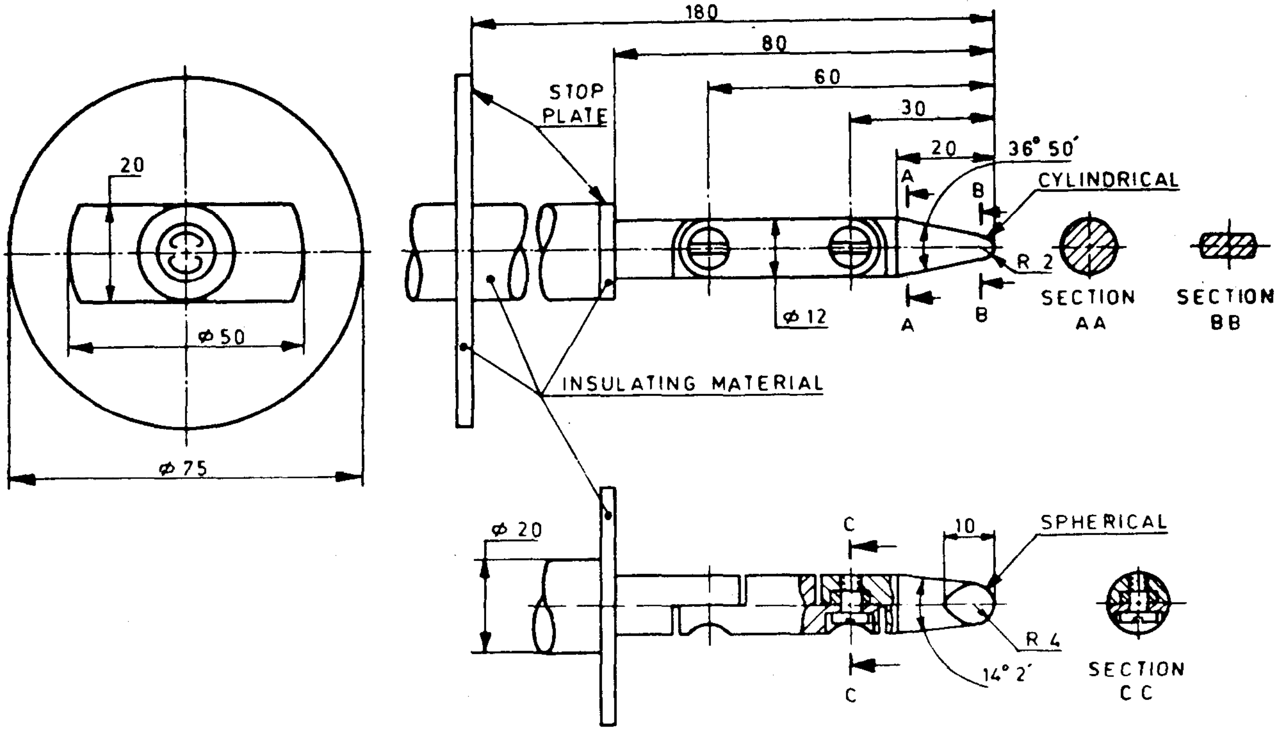
Tests carried out to prove conformity with the requirements of the standard. These are intended to prove the general qualities and design of a given type of appliance.

2.35 Acceptance Test

Tests carried out on samples taken from a lot for the purpose of acceptance of the lot.

2.36 Routine Test

Tests carried out on each item to check the essential requirements which are likely to vary during production.



Both joints of this finger may be bent through an angle of 90°, but one and the same direction only.

Tolerances :

On angles : ± 5°

On linear dimensions : Less than 25 mm : $^{+\ 0}_{-\ 0.05}$

: Over 25 mm : ± 0.2

All dimensions in millimetres.

FIG. 1 STANDARD TEST FINGER

2.37 Visible Glowing Heating Element

A heating element which, when the appliance is assembled ready for use, is partly or completely visible from the outside of the appliance, and the temperature of which is at least 650°C after the appliance has been operated in accordance with conditions of adequate heat discharge until steady conditions have been established, the supply voltage being such that the input is equal to the minimum rated input.

NOTE — This definition is mainly intended for testing with test probes regarding accessibility of live parts.

2.38 Hob

Denotes horizontal part of appliance which carries or contains the heating plate.

2.39 Heating

Heating unit designed to accommodate a vessel on its upper surface.

3 GENERAL REQUIREMENT

3.1 Appliances shall be so designed and constructed that in normal use they function safely so as to cause no danger to persons or surroundings, even in the event of such careless use as may occur in normal service.

4 GENERAL NOTES ON TESTS

4.1 The type tests are made on 2 samples, which shall withstand all the relevant type tests given in Annex A. The acceptance tests and routine tests are also given in Annex A.

4.2 If it is evident from the design of the appliance that a particular test is not applicable that test shall not be performed.

4.3 In case the appliance is taken from shelf (after long storage) and subjected to leakage current and high voltage tests in isolation, the test shall be conducted after 10 minutes of operation as specified in **2.20**.

4.4 Before testing is started the appliance is operated at rated voltage in order to verify that it is in working order.

4.5 The appliance shall be tested with the flexible cord supplied.

4.6 The components, if required for testing should be submitted along with sample.

4.7 Appliances fitted with thermostat, energy regulating device, temperature control and similar device are tested with these controls adjusted to their most unfavourable setting, if the setting can be altered by the user.

NOTES

1 If the adjusting means of the control is accessible without the aid of a tool, the provisions apply whether the setting can be altered by hand or with the aid of a tool; if the adjusting means is not accessible without the aid of a tool, the provisions apply only if the setting can be altered by hand.

2 Adequate sealing is regarded as preventing alteration of the setting by the user.

4.8 Measuring Instruments

The measurement of voltage and power shall be carried out with such instruments which do not themselves appreciably affect the values to be measured. The meters shall have an accuracy of Class I specified in IS 1248 (Part 1) : 1983.

4.9 A list of test equipment needed for conducting tests is given in Annex B.

5 RATING

5.1 Rated Voltage

The rated voltage shall not exceed 250 V. The preferred rated voltage is 240 V ac.

5.2 Rated Input

The rated input of the heating element of an electric stove shall be one of the following :

750, 1 000 and 1 500 W

NOTE — In case there are more than one heating element, even then, the total rating shall not exceed 1 500 W.

6 MARKING

6.1 Each electric stove shall be marked legibly and durably with :

a) rated voltage or rated voltage range;
b) symbol for nature of supply;
c) rated frequency or rated frequency range in hertz;
d) rated input in watts or kilowatts;
e) manufacturer's name, trade-mark or identification mark;
f) manufacturer's model or type reference;
g) thermal efficiency; and
h) country of origin.

NOTE — The rated input is total input of the circuits that can be in operation simultaneously.

6.1.1 If supplied separately with electric stove, the detachable heating element shall be marked either on the heating element or on wrapper/carton covering the heating element and the instructions leaflet with the following information :

a) Rated voltage(s);
b) Rated input in watts or kilowatts;
c) Manufacturer's name, trade-mark, or identification mark; and
d) Manufacturer's model or type reference.

6.2 When symbols are used, they shall be as follows :

V	volts
Hz	hertz

W	watts
kW	kilowatts
~	alternating current
⎓	direct current

NOTE — The symbol for nature of supply shall be placed next to the marking for rated voltage.

6.3 Terminals intended exclusively for the neutral conductor shall be indicated by the letter 'N'.

Earthing terminals shall be indicated by the symbol ⏚.

These indications shall not be placed on screws, removable washers or other parts which might be removed when conductors are being connected.

6.4 The different positions of regulating devices and the different positions of switches on stationary appliances shall be indicated by figures, letters or other visual means.

If figures are used for indicating the different positions, the 'off' position shall be indicated by the figure '0' and the position for a greater output, input, speed, cooling effect, etc, shall be indicated by a higher figure.

6.5 The figure '0' shall not be used for any other indication.

Thermostats, regulating devices and the like, intended to be adjusted during installation or in normal use, shall be provided with an indication for the direction of adjustment to increase or to decrease the value of the characteristic being adjusted.

NOTE — An indication of + and – is considered to be sufficient.

6.6 An instruction sheet, giving necessary instructions including precautions to be taken for the proper use of electric stove shall be provided.

6.7 Where symbols are used, they shall be as indicated in **6.2**. Compliance with the requirements of **6.1** to **6.7** is checked by inspection.

Marking specified in **6.1** to **6.7** shall be on a main part of the appliance or detachable heating element as relevant.

Marking and indications for switches, thermostats, thermal cut-outs and other control devices shall be placed in the vicinity of these components; they shall not be placed on removable parts if these parts can be replaced in such a way that the marking becomes misleading.

The marking shall be clearly discernable from outside.

Compliance is checked by inspection and by rubbing the marking by hand for 15 seconds with a piece of cloth soaked with water and again for 15 seconds with a piece of cloth soaked with petroleum spirit. The marking shall be easily legible, it shall not be easily possible to remove marking plates and they shall show no curling.

NOTE — In considering the durability of the marking, the effect of normal use is taken into account. Thus, for example, marking by means of paint or enamel other than vitreous enamel on containers that are likely to be cleaned frequently is not considered to be durable.

7 PROTECTION AGAINST ELECTRIC SHOCK

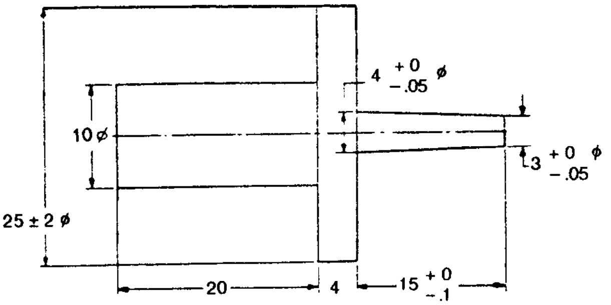
7.1 The appliance shall be so designed that its enclosures give adequate protection against accidental contact with live parts and also with glowing heating elements. This requirement applies for all positions when it is assembled and operated as in normal use, even if after opening of lids, removable/detachable parts, provided the appliance can be isolated from supply by means of a plug or an all pole switch. The enclosures shall have no opening other than that necessary for use and working of the appliance, giving access to live parts.

The insulating properties of lacquer, enamel, ordinary paper, oxide film on metal parts, beads and sealing compound shall not be relied upon to give the required protection against accidental contact with live parts. Self healing resins are not regarded as sealing compounds.

NOTE — If during the normal operation or for maintenance by user, any part is required to be detached even with the help of a tool, that parts is regarded as detachable part.

7.2 Compliance is checked by inspection except for glowing heating elements and part supporting such elements, by a test with standard test finger shown in Fig. 1. In addition, the apertures other than those in metal parts connected to the earthing terminal, are tested with test pin shown in Fig. 2. The test finger, and test pin are applied, without appreciable force, in every possible position.

For glowing elements, the test of **7.4** is carried out.



All dimensions in millimetres.

FIG. 2 TEST PIN

7.3 For appliances provided with movable devices, such as those intended for varying the heat distribution the test is made with the devices adjusted to their most unfavourable position within their range of adjustment.

Apertures preventing the entry of the finger are further tested by means of a straight unjointed test finger of the same dimensions, which is applied with a force of 20 N; if this finger enters, the test with the finger shown in Fig. 1, is repeated, the finger being introduced through the aperture. If the unjointed test finger does not enter, the force applied is increased to 30 N. If then the guard is so displaced or the aperture so distorted that the test finger shown in Fig. 1 can be inserted without force, the test with the latter finger is repeated. An electrical contact indicator is used to show contact.

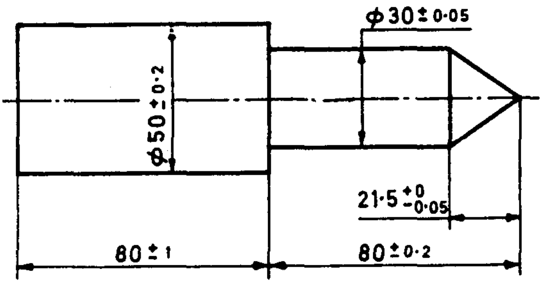
It shall not be possible to touch bare live parts or live parts protected by lacquer, enamel, ordinary paper, cotton, oxide film, beads or sealing compound only, with the test finger. In addition, it shall not be possible to touch bare live parts with the test pin when testing apertures of the insulation moulded enclosure.

7.4 The test for live parts of visibly glowing heating elements all poles of which can be disconnected by a single switching action, and for parts supporting such elements, provided that it is obvious from the outside of the appliance, without removing covers and the like, that these parts are in contact with the element, is made with the test probe shown in Fig. 3, instead of the test finger, the probe being applied without appreciable force. It shall not be possible to touch live parts with this probe.

NOTES

1 The standard test finger must be so designed that each of the jointed sections can be turned through an angle of 90° with respect to the axis of the finger in the same direction only.

2 It is recommended that a lamp be used for the indication of contact with live parts and the voltage rating of the lamp shall be in the range of 40 to 75 volts.



All dimensions in millimetres.

FIG. 3 TEST PROBE

7.5 Shafts of operating knobs, handles, levers and the like shall not be live when tested by test pin specified in **7.2**. Handles, levers and knobs which are held or actuated in normal use shall not become live in the event of an insulation fault. If these handles, levers or knobs are of metal and if their shaft or fixings are likely to become live in the event of an insulation fault, they shall either be adequately covered by insulating material or their accessible parts shall be separated from their shafts or fixings by supplementary insulation.

8 INPUT AND CURRENT

8.1 The input of the appliance or of detachable heating element, at the rated voltage and at normal operating temperature, shall not deviate from rated input by more than 10 percent.

8.2 When electric stoves are fitted with or are intented to be used in conjunction with thermostats or thermal cut-outs, the input is measured immediately before the cut-outs operate for the first time after an operating period of 30 minutes.

8.3 The compliance is checked by measurement of input of appliances or detachable element in accordance with conditions of adequate heat discharge (*see* **2.20**) and when the input has stabilized.

NOTE — For appliances and detachable heating elements marked with a rated voltage range having limits differing by more than 10 percent of the mean value of the range, the permissible deviation applies for both limits of the range.

9 TEMPERATURE-RISE

9.1 Appliances and their surroundings shall not attain excessive temperatures in normal use.

Compliance is checked by determining the temperature-rise of the various parts under the conditions specified in **9.2** to **9.6**.

9.2 The heating appliances are placed in a test corner. The test corner consists of two walls at right angles, a floor and, if necessary, a ceiling, all of dull-black painted plywood having a thickness of 20 mm. The appliance is positioned in the test corner as follows:

> 'Appliances normally used on the floor or table are placed on the floor of the test corner at a distance of about 15 cm from the walls of the test corner.'

NOTE — This distance includes the natural projections such as hooks, bolts, appliance inlets, etc, of the appliance.

9.3 Temperature-rises are determined by means of fine-wire thermocouples so chosen and positioned that they have the minimum effect on the temperature of the part under test. Thermometers may also be used wherever feasible (*see* Annex C).

Thermocouples used for determining the temperature-rise of the surface of walls, ceiling and floor are embedded in the surface or attached to the back of small blackened discs of copper or brass, 15 mm in diameter and 1 mm thick, which are flush with the surface.

So far as is possible, the appliance is positioned so that parts likely to attain the highest temperatures touch the discs.

In determining the temperature-rises of handles, knobs, grips and the like, consideration is given to all parts which are gripped in normal use and if of insulating material, to parts in contact with hot metal.

The temperature-rise of electrical insulation is determined on the surface of the insulation, at places where failure could cause a short circuit, contact between live parts and accessible metal parts bridging of insulation or reduction of creepage distances or clearances below the values specified in Table 2.

9.4 Electric stoves are operated in accordance with the conditions of adequate heat discharge with all the heating elements that can be switched on at the same time being in circuit, the supply voltage being such that the input is 1.15 times the highest value of the sum of the rated input that can be switched on at the same time.

9.5 The electric stove is operated under conditions of adequate discharge until steady state conditions are established or for 60 minutes, whichever is earlier. The control devices are at the highest setting until the water boils and then the control devices are adjusted so as to maintain the water gently boiling, the pan being covered with the lid.

9.6 During the test, thermal cut-outs shall not operate, the temperature-rises are to be monitored continuously and shall not exceed the values shown in Table 1 and sealing compound, if any, shall not flow out, and

- a) The temperature of accessible exterior surface below a plane 50 mm below the top hob surface of the electric stove shall not exceed 150°C, and
- b) Temperature-rise of the walls of the test corner shall not exceed 65°C.

10 OPERATION UNDER OVERLOAD CONDITIONS

10.1 Appliance shall be so designed and constructed that they withstand overloads liable to occur in normal use.

Compliance is checked by test of **10.2**.

After the test the appliance shall show no damage affecting the compliance.

In particular, general assembly shall not show such deformation that creepage distances and clearances are reduced below the values specified in Table 2. Contacts and connections shall not have worked loose.

10.2 The appliance is placed on a horizontal support, away for walls. The appliance is subjected to 15 cycles, each cycle comprising of operating period as specified in **9.5**, in accordance with conditions of adequate heat discharge and a cooling period sufficient to allow the appliance to cool down to approximately room temperature.

Throughout the operating period, the supply voltage being such that the input is 1.27 times the rated input or 1.21 times the rated input +12 watts whichever is greater.

If the thermal cutout or temperature control device which is accessible and can be reset with the aid of a tool operates, the operating period is considered to have ended. The appliance is then allowed to cool down and the thermal cutout is reset for the next cycle. During the test the thermal cutouts which are only accessible with the aid of a tool or which require replacement of a part shall not operate and no vapour or ignitable gas accumulate in the enclosure.

NOTE — The forced cooling may be used to shorten the cooling period.

11 ELECTRICAL INSULATION AND LEAKAGE CURRENT AT OPERATING TEMPERATURE

11.1 The electrical insulation of the appliance at operating temperature shall be adequate and the leakage current in normal use shall not be excessive.

Compliance is checked by the test given in **11.2** and by the additional test given in **11.3** the appliance being operated in accordance with conditions of adequate heat discharge for the time specified in **9.5**.

The appliance is operated with all heating elements in circuit, the supply voltage being such that the input is 1.15 times the maximum rated input.

11.2 Leakage Current Test

11.2.1 The leakage current is measured between any

Table 1 Temperature-Rise Limits

(*Clause* 9.6)

	Parts	Temperature-Rise °C
1.	Rubber or PVC insulation of internal or external wiring including power supply cord	35
2.	Pins of appliance inlets	
	a) for hot conditions	115
	b) for cold conditions	25
3.	Terminals or terminations for Type M, attachments — For power supply cord	20
	Cord sheath used as supplementary insulation	20
4.	Handles, knobs, grips which are held for short period only :	
	— of metal	20
	— of porcelain or viterious material	30
	— of moulded material, rubber, wood	45
5.	Wooden supports, walls, ceiling and floor of test corners and wood cabinet	50

pole of the supply and the accessible metal parts and metal foil with an area not exceeding 20 cm x 10 cm in contact with accessible surfaces of insulating materials connected together.

11.2.2 The resistance of the measuring circuit is 2 000 ± 100 ohms. The test circuit for leakage current is shown in Fig. 4.

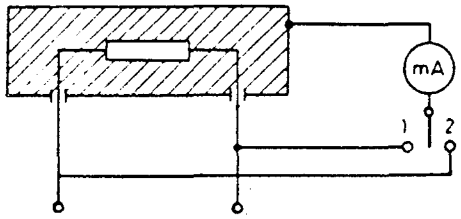


FIG. 4 DIAGRAM FOR LEAKAGE CURRENT MEASUREMENT AT OPERATING TEMPERATURE

11.2.3 The test is made with ac, unless the appliance is for dc only, for which case the test is made with dc. The leakage current is measured with the selector switch shown in Fig. 4 in each of the positions 1 and 2.

11.2.4 After an operating time as specified in **9.5**, the leakage current which may flow from live parts to the accessible metal parts and metal foil on external insulating material connected together shall not exceed 300 μA (peak), that is, 210 μA (rms).

NOTE – The appliance shall be well insulated from earth during leakage current measurements. Earthing connections shall not be made during the leakage current test.

11.3 High Voltage Test

11.3.1 The insulation is subjected for one minute to a voltage of substantially sine-wave form of 1 000 V having a frequency of 50 Hz or 60 Hz, the connections are shown in Fig. 5.

The test voltage is applied :

a) between live parts and the body, and
b) between live parts and parts connected to the earth wire.

Initially not more than half the prescribed voltage is applied, then it is raised rapidly to the full value of 1 000 V.

11.3.1.1 No flashover or breakdown shall occur during the test. Glow discharges without drop in voltage are neglected.

The high-voltage transformer used for the test has a rating of at least 500 VA.

11.3.1.2 If the secondary winding of the isolating transformer is not provided with a tap at the midpoint, the output winding of the high-voltage transformer can be connected to the midpoint of a potentiometer having a total resistance not exceeding 2 000 Ω, and connected across the output winding of the isolating transformer.

11.3.2 When applied as a routine test, the high voltage test may also be carried out as a flash test. The appliance may not be connected to the supply and an ac voltage one and a half times the value given in **11.3.1** shall be applied for a period of 5 seconds.

11.4 In case the electric stove is taken from shelf and subjected to leakage current and high voltage tests in isolation, the tests shall be conducted after 10 minutes of preheating.

12 MOISTURE RESISTANCE

12.1 Appliance shall be proof against humid conditions which may occur in normal use.

Compliance is checked by the humidity treatment described in this clause, followed immediately by test given in **13**.

Electrical components, including detachable heating elements, covers and other parts which can be removed without the aid of a tool, are removed and subjected, if necessary, to the humidity treatment with the main part.

The humidity treatment is carried out in a humidity cabinet containing air with a relative humidity of not less than 90 percent. The temperature of the air, at all places where samples can be located, is maintained at any convenient value (t) between 15°C and 35°C.

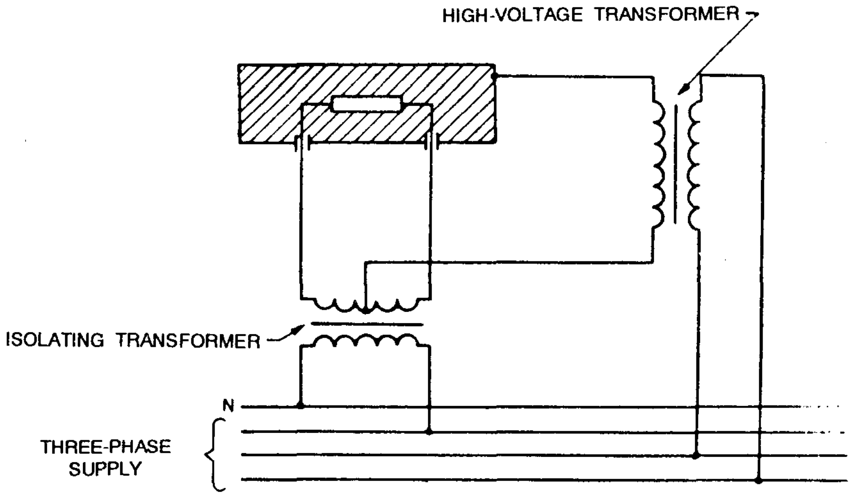


FIG. 5 DIAGRAM FOR ELECTRIC STRENGTH TEST AT OPERATING TEMPERATURE

Before being placed in the humidity cabinet, the sample is brought to a temperature between t and $t + 4$°C.

The sample is kept in the cabinet for 2 days (48 hours).

NOTES

1 In most cases, the sample may be brought to the specified temperature by keeping it at this temperature for at least 4 hours before the humidity treatment. A relative humidity of approximately 95 percent can be obtained by placing in the humidity cabinet a saturated solution of sodium sulphate (Na_2SO_4) or potassium nitrate (KNO_3), in water, having a sufficiently large contact surface with the air.

2 In order to achieve the specified conditions within the cabinet, it is necessary to ensure constant circulation of the air within and, in general, to use a cabinet which is thermally insulated.

12.2 After this treatment, the appliance shall show no mechanical, electrical failure or ferrous parts getting rusted (show sign) and shall be tested for **13**.

13 INSULATION RESISTANCE AND ELECTRIC STRENGTH (AFTER HUMIDITY TREATMENT)

13.1 The insulation and electric strength of appliance shall be adequate.

Compliance is checked by tests given in **13.2** and **13.3** which are on cold appliance, after the test given in **12** in the humidity cabinet or in the room in which the sample was brought to the prescribed temperature after reassembly of those parts which might have been removed.

13.2 A test voltage, dc for appliances for dc only and ac for all other appliances, is applied as given in table of **13.3**, the metal foil having a size not exceeding 20 cm × 10 cm and being moved, if necessary so as to test all parts of the surface.

13.2.1 The input test voltage is raised to 1.06 times the rated voltage or 1.06 times the upper limit of the rated voltage range. The leakage current measured shall not exceed the values given in **11.2.4**.

NOTE – Appliance may be operated up to 10 minutes before leakage current measurements.

13.2.1.1 The values specified in **11.2.4** are doubled if the appliance has no control device other than a thermal cut-out, thermostat without an 'OFF' position or an energy regulator without an 'OFF' position; and if all control devices have an 'OFF' position with a contact opening of at least 3 mm and all pole disconnection.

13.3 Immediately after the test given in **13.2**, the insulation is subjected for one minute to a voltage of substantial sine-wave form having frequency of 50 or 60 Hz. The value of the test voltage and the points applicable are :

Sl No.	*Points of Application of Test Voltage*	*Test Voltage*
1.	Between live parts and the parts of the body that are separated by :	
	— basic insulation	1 000 V
	— reinforced insulation	3 750 V
2.	Between the body and either the power supply cord wrapped with metal foil or a metal rod of the same diameter as the supply cord inserted in its place, fitted in inlet bushings of insulating materials, cord guards, cord anchorages and the like	1 000 V
3.	Between metal foil in contact with handles, knobs, grips and their shaft, if these shafts can become live in the event of an insulation fault	2 500 V

NOTE – The test is not made between the contacts of switches of micro-gap construction, thermostats or the like.

13.3.1 Initially, not more than half the prescribed voltage is applied, then it is raised rapidly to the full value.

13.3.2 No flashover or breakdown shall occur during the test.

Care is taken that the metal foil is so placed that no flashover occurs at the edges of the insulation.

14 ENDURANCE

14.1 Appliances shall be so constructed that, in normal use, there will be no electrical or mechanical failure that might impair compliance with this guide. The insulation shall not be damaged and contacts and connections shall not work loose as a result of heating, vibration, etc.

14.2 The electric stove shall be connected to the supply under conditions of adequate heat discharge (*see* **2.20**) and such that the input is 1.10 times the maximum rated input which shall be maintained throughout the test. The endurance test shall consist of 500 cycles each cycle comprising of two hours ON and a maximum of one hour OFF.

14.2.1 During the test, 20 spillages, each consisting of 150 ml of 0.5 percent solution of sodium chloride in distilled water at room temperature shall be projected in a period of one minute over the stove subject to the conditions that :

a) there shall not be more than 4 spillages in any 100 cycles, and these shall be equally spaced, as nearly as possible, over the time involved; and

b) alternative spillages shall be made on the stove in hot and cold conditions, that is 15 minutes after commencement of an ON' period and 15 minutes after the commencement of 'OFF' period.

14.2.2 Immediately after each spillage the leakage current shall be measured in accordance with **11.2** without the ten minutes heating period.

14.2.3 Five minutes after each spillage, the electric stove shall be subjected to a mechanical shock test by allowing a hardened steel ball, 75 mm in diameter, to drop freely six times from a height of 150 mm on to a 3 mm thick steel plate (which shall be of a size sufficient to cover the top surface of the heating element) placed on the electric stove. Care should be taken that the ball falls on different parts of the surface of the steel plate, these parts being selected at random.

14.3 After the test in **14.2**, the appliance shall withstand high voltage test given in table of **13.3**. The connections, handles, guards or other fittings shall not have worked loose, and there shall be no deterioration affecting safety in normal use.

Moreover, the overload protection devices, if provided shall not operate during endurance test.

15 ABNORMAL OPERATION

15.1 Appliances shall be so designed that the risk of fire, mechanical damage impairing safety or the protection against electric shock as a result of abnormal or careless operation is obviated as far as is practicable.

Compliance is checked by the tests of **15.2** and **15.3** if necessary by **15.4** and **15.5**.

If a non-self-resetting thermal cut-out operates, a heating element ruptures or if the current is otherwise interrupted before steady conditions are established, the heating period is considered to be ended, but if the interruption is due to the rupture of a heating element or of an intentionally weak part, the relevant test is repeated on a new sample which shall then also comply with the conditions specified in **15.5**.

Rupture of a heating element or of an intentionally weak part in the second sample will not in itself entail a rejection.

Fuses, thermal cut-outs, overcurrent releases or the like, incorporated into the appliance, may be used to provide the necessary protection.

15.2 The appliance is placed in the test corner as specified in **9.2** and is operated without adequate heat discharge condition, with supply voltage being such that the input is 0.85 times the rated input in watts.

If a non self-setting thermal cut-out or temperature limiting device operates or if the current is interrupted before the steady conditions are established, the operating period is considered to have ended and test of **15.3** is not made. If the current is not interrupted, the appliance is switched off as soon as the steady conditions are established and is allowed to cool to nearly room temperatures. Then the test of **15.3** is made.

NOTE — The conditions without adequate heat discharge corresponds to operation of electric stove without pan. In case there is control device, it shall be at its highest setting.

15.3 The test of **15.2** is repeated but with a supply voltage such that the input is 1.24 times the rated input in watts.

15.4 The test of **15.3** is repeated, but with appliance operated under adequate heat discharge and with thermal control devices short circuited.

15.5 During the test of **15.1** to **15.4** the appliance shall not emit flames or molten metal or poisonous or ignitable gas in hazardous amounts, enclosures shall not be deformed to such an extent as will impair the safe use and also the temperature rise shall not exceed the values given below :

Walls, ceiling and the floor of the test corner	150°C
Insulation of the supply cable or cord	150°C
Supplementary insulation and reinforced insulation other than those of thermoplastic materials	1.5 times the values for such parts as given in Table 1

In addition to the temperature-rises, the insulation of the appliance, when cooled down to room temperature shall withstand high voltage test of 1 000 V between the live parts and the enclosure or earthing lead.

The supplementary insulation or reinforced insulation of thermoplastic material are tested for requirements of **26.1**.

16 STABILITY AND MECHANICAL HAZARDS

16.1 The appliance shall have adequate stability.

Compliance is checked by **16.2**; appliances provided with an appliance inlet shall be fitted with an appropriate connector, flexible cable and three pin plug.

16.2 The appliance is placed in any normal position of use on a plane inclined at an angle of 10° to the horizontal, the cable or cord resting on the inclined plane in the most unfavourable position. This test shall be repeated by placing the appliance on horizontal plane and raising through an angle of 10° to the horizontal.

The appliance shall also be tested with the vessal containing liquid of appropriate quantity in conditions given in **2.20** in most unfavourable position.

The appliance shall not overturn.

If an appliance overturn in one or more positions, it is subjected to the test of **9** in all overturned positions. During this test, the temperature rises shall not exceed the values given in **15.5**.

17 MECHANICAL STRENGTH

17.1 Appliances shall have adequate mechanical strength and be so constructed as to withstand such rough handling as may be expected in normal use.

Compliance is checked by applying blows to the sample, by means of the spring-operated impact-test apparatus shown in Fig. 6.

The apparatus consists of three main parts, the body, the striking element and the spring-loaded release cone.

The body comprises the housing, the striking element guide, the release mechanism and all parts rigidly fixed thereto. The mass of this assembly is 1 250 g.

The striking element comprises the hammer head, the hammer shaft and the cocking knob. The mass of this assembly is 250 g.

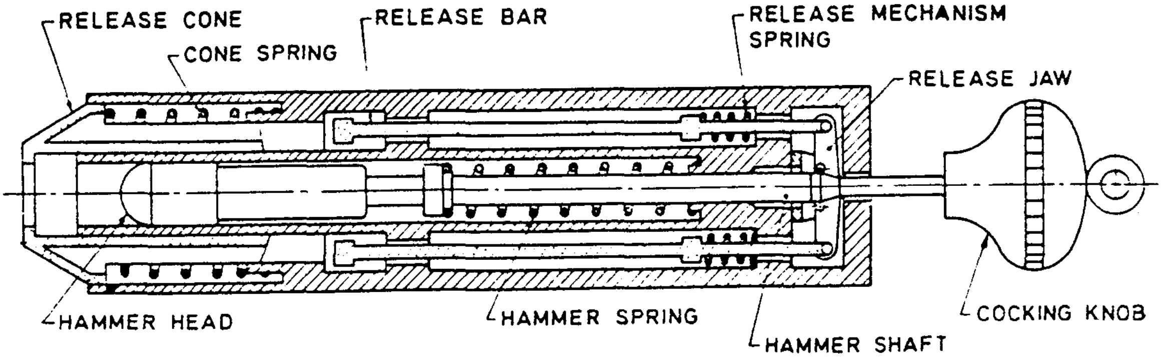


FIG. 6 IMPACT TEST APPARATUS

The hammer head has a hemispherical face of polyamide having a Rockwell hardness of *HR* 100, with a radius of 10 mm; it is fixed to the hammer shaft in such a way that the distance from its tip to the plane of the front of the cone when the striking element is on the point of release is 20 mm.

The cone has a mass of 60 g and the cone spring is such that it exerts a force of 20 N when the release jaws are on the point of releasing the striking element.

The hammer spring is adjusted so that the product of the compression, in millimetres, and the force exerted, in newtons, equals 1 000, the compression being approximately 20 mm. With this adjustment, the impact energy is 0.5 ± 0.05 Nm.

The release mechanism springs are adjusted so that they exert just sufficient pressure to keep the release jaws in the engaged position.

The apparatus is cocked by pulling the cocking knob until the release jaws engage with the groove in the hammer shaft.

The blows are applied by pushing the release cone against the sample in a direction perpendicular to the surface at the point to be tested.

The pressure is slowly increased so that the cone moves back until it is in contact with the release bars, which then move to operate the release mechanism and allow the hammer to strike.

The sample as a whole is rigidly supported and three blows are applied to every point of the enclosure that is likely to be weak.

To ensure that the sample is rigidly supported, it may be necessary to place it against a solid wall of brick, concrete or the like, covered by a sheet of polyamide which is tightly fixed to the wall, care being taken that there is no appreciable air gap between the sheet and the wall. The sheet must have a Rockwell hardness of *HR* 100, a thickness of at least 8 mm and a surface area such that no parts of the sample is mechanically overstressed due to insufficient supporting area.

If necessary the blows are also applied to handles, levers, knobs and the like.

17.1.1 After the test the sample shall show no damage in particular, live parts shall not have become exposed so as to impair compliance with **7**, and also there shall not have been such distortion to affect the creepage distances and clearances specified in Table 2. Cracks not visible to the naked eye and surface cracks in the fibre reinforced moulding are ignored.

17.2 When applying the release cone to the guard of a heating element which glows visibly in normal use, care is taken that the hammer head passing through the guard does not strike the heating element.

17.3 Damage to the finish, small dents which do not reduce creepage distances and clearances below the values specified in Table 2 and small chips which do not adversely affect the protection against electrical shock or moisture are neglected.

If a decorative cover is backed by an inner cover, fracture of the decorative cover is neglected if the inner cover withstands the test after removal of the decorative cover.

NOTE – The test may be carried out by the alternative method given in Annex D.

17.4 Accessible Surfaces

Accessible surfaces of glass, ceramic or similar brittle material used as essential insulation of heating elements in the hob shall have adequate mechanical strength.

Compliance is checked by the test of **17.4.1**.

17.4.1 A vessel, uniformally filled with sand or shot to a total mass of 1.8 kg is dropped flat from a height of 15 cm on to accessible surfaces of glass, ceramic or similar brittle material used as essential insulation of heating element in the hob.

The operation is carried out ten times in succession.

After this test, the surface shall not be broken and shall show no cracks visible to the naked eye.

NOTE — A vessel having a bottom of copper or aluminium which is flat over a diameter of 12 ± 1 cm and has edges rounded with a radius of at least 1 cm is considered to be appropriate for this test.

18 CONSTRUCTION

18.1 Appliances shall be of Class I with respect to protection against electric shock.

Compliance is checked by inspection and by the relevant tests of 7.

18.2 Appliances shall have the appropriate degree of protection against moisture.

Compliance is checked by inspection and by the relevant tests of **12**.

18.3 Appliances shall be so constructed that they operate in all positions to be expected in normal use.

Compliance is checked by verifying that the appliance operates correctly in all positions which deviate from the normal position of use by an angle not exceeding 5°.

This test is made only in case of doubt.

18.4 Portable appliances shall be constructed so as to prevent the penetration from table or floor of objects which might result in a hazard.

Appliances without legs are considered to comply with this requirement if all live parts are at least 6 mm from the supporting surface measured through any opening. If the appliance is fitted with legs, this distance is increased to 10 mm for appliances intended to be placed on a table and to 20 mm for appliances intended to be placed on the floor.

18.5 Appliances shall be so constructed that accidental changing of the setting of thermostats or other control devices is unlikely to occur if this might result in a hazard.

Compliance with the requirements of **18.4** and **18.5** is checked by manual test.

18.6 Reset buttons of non-self-resetting controls shall be so located or protected that their accidental resetting is unlikely to occur if resetting might result in a hazard.

Compliance is checked by inspection.

This requirement precludes, for example, reset buttons mounted on the back of an appliance in such a manner that they can be reset by pushing an appliance against a wall.

18.7 Handles, knobs, grips, levers and the like shall be fixed in a reliable manner so that they will not work loose in *normal* use if loosening might result in a hazard.

If handles, knobs and the like are used to indicate the position of switches or similar components, it shall not be possible to fix them in a wrong position if this might result in a hazard.

Compliance is checked by inspection, by manual test and by trying to remove the handle, knob, grip or lever by applying an axial force for 1 minute.

If the shape of these parts is such that an axial pull is unlikely to be applied in normal use, the force is :

15 N for actuating members of electrical components, and

20 N in other cases.

If the shape is such that an axial pull is likely to be applied, the force is :

30 N for actuating members of electrical components, and

50 N in other cases.

Sealing compounds and the like, other than self-hardening resins, are not considered to be adequate to prevent loosening.

18.8 Materials which burn fiercely, such as celluloid, shall not be used in the construction of appliances.

18.9 Wood, cotton, silk ordinary paper, thermocole, and silk, wool and similar fibrous or hygroscopic material shall not be used as insulation, unless *impregnated and dried.*

Asbestos is considered to be fibrous material within the meaning of this standard.

Insulating material is considered to be *impregnated* if the interstices between the fibres of the material are substantially filled with a suitable insulant.

18.10 Inside the appliance, the sheath (jacket) of a flexible cable or cord shall only be used as supplementary insulation where it is not subject to undue mechanical or thermal stresses and if its insulating properties are not less than those specified in IS 9968 (Part 1) : 1988 for the sheaths of flexible cables and cords.

18.11 Direct contact between bare live parts and thermal insulation shall be effectively prevented, unless such material is non-corrosive, non-hygroscopic and non-combustible.

Compliance is checked by inspection and by the tests of **12** and **13** and, if necessary, by chemical tests or flammability tests.

Glass-wool is an example of thermal insulation which is satisfactory for the purpose of this requirement.

Non-impregnated slag-wool is an example of corrosive thermal insulation.

18.12 Handles shall be so constructed that, when gripped as in normal use, contact between the operator's hand and parts having a temperature rise exceeding the value allowed for handles which, in normal use, are held for short periods only, is unlikely.

Compliance is checked by inspection and, if necessary, by determining the temperature-rise.

If the temperature-rise of a rivet or a screw in a barrier or handle exceeds the value specified for the handle in Table 1, the rivet or screw shall not be accessible.

18.13 Bare heating elements which glow visibly in normal use shall be so supported that, in case of rupture, the heating conductor cannot come into contact with accessible metal parts.

Compliance is checked by inspection, after cutting the heating conductor in the most unfavourable place.

This requirement applies even if the glowing heating element is not visible from the outside of the appliance. The test is made after the tests of **25.1**.

18.14 Spacers intended to prevent the appliance from overheating walls and the like shall be so fixed that it is not possible to remove them from the outside of the appliance by means of a screwdriver or spanner.

Compliance is checked by inspection and by manual test.

18.15 Current-carrying parts and other metal parts, the corrosion of which might result in a hazard, shall be resistant to corrosion under normal conditions of use.

Compliance is checked by verifying that after the tests of 15, the relevant parts show no sign of corrosion.

Attention must be paid to compatibility of the materials of terminals and terminations and to the effect of heating.

Stainless steel and similar corrosion-resistant alloys and plated steel are considered to be satisfactory for the purpose of this requirement.

18.16 For appliances having compartments to which access can be gained without the aid of a tool and which are likely to be cleaned in normal use, the electrical connections shall be so arranged that they are not subject to pulling during user maintenance.

Compliance is checked by inspection and by manual test.

18.17 The heating surface shall be in one plane.

18.18 The heating elements shall be so designed and supported that they maintain their intended position in the stove. It shall not be possible for a broken element to fall out of the stove, or for an element to become displaced when the stove is lifted by the carrying handle.

18.19 The heating elements of the replaceable type shall be so designed and constructed as to be easily replaceable.

18.20 When selecting materials for connecting heating element terminations, care shall be taken to choose those which are compatible with the type of resistance material used. Terminals and terminal parts of the heating elements shall be nickle-plated or otherwise protected from corrosion unless made from non-corroding material.

18.21 Heating elements shall be protected by means of metal guards to prevent any inadvertent contact by person, or with any object adjacent to the electric stove. The purpose of the guards is to reduce or prevent the risk of fire or electric shock due to accidental contact with or proximity to heating elements.

18.21.1 The guards shall be of robust construction and securely attached to the electric stove. If the guard is so designed and attached that the whole or any portion of the guard can be removed, lifted or swung to one side for maintenance purposes, the methods of attachments shall be such that the guard, when replaced, cannot be accidentally dislodged from its working position during normal use.

18.21.2 It shall not be possible to touch the wires or terminations of the heating element or their contact members with any part of a test finger conforming to Fig. 1 when such a probe is inserted through or around the guard without undue pressure.

18.22 Electric stove shall be provided with a handle or other suitable means of handling, securely attached to it. Grip of the handle provided shall be of a material electrically non-conducting and heat-insulating.

18.23 Switches and wiring shall be so situated or protected that they are unaffected by steam, vapour or spillage produced during normal cooking operation.

18.23.1 Control switches, if provided shall be so located that in normal use they are easily accessible, but are not exposed to damage.

19 INTERNAL WIRING

19.1 Wireways shall be smooth and free from sharp edges.

Wires shall be protected so that they do not come into contact with burrs, cooling fins, etc, which may cause damage to their insulation.

Holes in metal through which insulated wires pass shall have smooth well-rounded surfaces or be provided with bushings.

19.2 Internal wiring and electrical connections between different parts of the appliance shall be adequately protected or enclosed.

Compliance of **19.1** *and* **19.2** *is checked by inspection.*

19.3 Beads and similar ceramic insulators on live parts (wires or others) shall be so fixed or supported that they can not appreciably change their position; they shall not rest on sharp edges or sharp corners.

Compliance is checked by inspection and by manual tests.

19.4 Internal wiring and heating conductors shall be either so rigid and so fixed or so insulated that, in normal use, creepage distances and clearances cannot be reduced below the values specified in Table 2.

The insulation, if any, shall be such that it cannot be damaged in normal use.

Compliance is checked by inspection, by measurement and by manual test.

If the insulation of a conductor is not at least electrically equivalent to that of the cables or flexible cords complying with IS 9968 (Part 1) : 1988 that conductor is considered to be a bare conductor. In case of doubt, an electric strength test is made between the conductor and metal foil wrapped round the insulation, a test voltage of 1 500 V being applied for 15 minutes.

Particular attention is paid to the anchoring of the ends of heating conductors.

19.5 Conductors identified by the colour green shall not be connected to terminals other than earthing terminals.

20 COMPONENTS

20.1 The thermostats, thermal cut-outs or the like, if used shall be selected to meet the requirements related to abnormal operation, endurance test and the tests given in Annex E.

20.2 The appliance shall not be fitted with the following :

a) Switch in flexible cable or cord.

b) Device which, in the event of a fault in appliance, causes the interruption of supply by applying short circuit.

c) Thermal cut-outs that can be reset by a soldering operation.

20.3 The plugs and socket outlets used as terminal devices for heating elements shall not be interchangeable with plugs and socket outlets complying with IS 1293 : 1988 or with connectors and appliance inlets complying with IS 3010 (Parts 1 and 2) : 1965.

Compliance to **20.2** and **20.3** is checked by inspection and by manual test.

20.4 The following components/parts, generally used in appliances and covered in Indian Standards and are given below for guidance :

Component	*Indian Standard*
a) Cable and cords	IS 9968 (Part 1) : 1988 Elastomer insulated cables: Part 1 For working voltages up to and including 1 100 V (*first revision*)
b) Appliance connector	IS 3010 (Part 1) : 1965 Appliance connectors and appliance inlets (non-reversible three-pin type) : Part 1 Appliance connectors IS 3010 (Part 2) : 1965 Appliance connectors and appliance inlets (non-reversible three-pin type) : Part 2 Appliance inlet
c) Three-pin plugs and socket outlets	IS 1293 : 1988 Plugs and socket outlets of rated voltage up to and including 250 volts and rated current up to and including 16 amperes (*second revision*)
d) Resistance wires, tapes and strips for heating elements	IS 3725 : 1966 Resistance wires, tapes and strips for heating elements
e) Cold rolled sheet steel	IS 513 : 1986 Cold rolled low carbon sheet and strips
f) Moulding material (insulation)	IS 3389 : 1965 Urea formaldehyde moulding powder
g) Switches	IS 3854 : 1988 Switches for domestic and similar purposes

20.5 Refractory material if used shall be of adequate mechanical strength and durability as to withstand the mechanical shock test specified in **14.2** and **17.4**. It shall not deteriorate by alternate heating and cooling normal in service.

21 SUPPLY CONNECTION AND EXTERNAL FLEXIBLE CABLE AND CORD

21.1 Appliances shall be provided with a power supply cord cable or an appliance inlet for connection to the supply. The length of the power supply cord external to the appliance shall be not less than 2 m. PVC insulated or PVC insulated and sheathed cables or cords shall not be used as the cable may attain a temperature of 75°C or more by contact with the hot surface of the stove.

Compliance is checked by inspection.

21.2 Power supply cords shall be assembled with the appliance by one of the following methods :

Type X attachment, and

Type M attachment.

Compliance is checked by inspection and, if necessary, by manual test.

21.3 The power supply cord/cable shall be provided with a three-pin plug (*see* IS 1293 : 1988).

Compliance is checked by inspection and measurement.

21.3.1 The power supply cord/cable shall be of 3 core, tough rubber sheathed flexible cable with copper conductor [*see* IS 9968 (Part 1) : 1988].

21.3.2 The power supply cord shall be provided with a green core, which is connected to the internal earthing terminal of the appliance and to the earthing contact of the plug. The colour of the cores intended for live and neutral connection shall be red and black respectively.

21.3.3 Power supply cords shall not be exposed to sharp points within, or cutting edges of, the surface of the appliance.

21.4 The size of conductor of power supply cord shall not be less than the following :

Rated Current of Appliance	*Nominal Cross Sectional Area Min/mm²*
Up to and including 3A	0.50
Over 3 up to and including 10 A	0.75

Compliance is checked by inspection and measurement.

21.5 Inlet openings shall be so designed and shaped, or shall be provided with an inlet bushing such, that the protective covering of the power supply cord can be introduced without risk of damage.

The insulation between the conductor and the enclosure shall consist of the insulation of the conductor and, in addition at least one separate insulation consisting of :

a) the sheath of a power supply cord at least equivalent to that of a cable or cord complying with IS 9968 (Part 1) : 1988; or

b) a lining of insulating material complying with the requirements for supplementary insulation; or

c) a bushing of insulating material complying with the requirements for supplementary insulation, in case of metal enclosures; or

d) an enclosure of insulating material in which case two separate insulations are not necessary.

Compliance is checked by inspection and manual test.

21.6 Appliances may be provided with a cord guard at the inlet opening for the power supply cord, unless the inlet or bushing is provided with a smoothly rounded bell-mouthed opening, having a radius of curvature at least equal to 1.5 times the overall diameter of the cable or cord with the largest cross-sectional area to be connected.

Cord guards if provided, shall :

a) be so designed as to protect the cable or cord against excessive bending where it enters into the appliance;

b) be of insulating material;

c) be fixed in a reliable manner;

d) project outside the appliance for a distance beyond the inlet opening of at least five times the overall diameter or, for flat cords, at least five times the major overall dimension, of the cable or cord delivered with the appliance or they shall comply with the flexing test; and

e) be integral with the power supply cord except for Type X attachment.

Compliance is checked by inspection, by measurement and by the following test.

The appliance is tested with the cable or cord, which has a length of approximately 10 cm.

The appliance is so held that the axis of the cord guard, where the cable or cord leaves it, projects upwards at an angle of 45° to the horizontal when the cable or cord is free from stress.

A mass equal to $10 D^2$ g is then attached to the free end of the cable or cord, D being, in millimetres, the overall diameter or, for flat cords, the minor overall dimension, of the cable or cord delivered with the appliance.

If the cord guard is of material which is sensitive to temperature, the test is made at a temperature of 27 ± 2°C.

Flat cords are bent in a direction perpendicular to the plane containing the axes of the cores.

Immediately after the mass has been attached, the radius of curvature of the cable or cord shall nowhere be less than $1.5\, D$.

For guards which do not comply with the dimensional requirement of this clause, a sample of the guard, together with the cable or cord delivered with the appliance, is to be subjected to 5 000 cycles of flexing. The guard is mounted in the appliance with a 60 cm to 100 cm length of cord. With the appliance held stationary, the guard is flexed by moving the cord back and forth in a plane through an angle of approximately 180°. At the end of the test, the guard and the cord shall show no unusual signs of abrasion or wear.

21.7 Appliances provided with a power supply cord shall have cord anchorages such that the conductors are relieved from strain, including twisting, where they are connected within the appliance, and that the insulation of the conductors is protected from abrasion.

21.7.1 If, for Type X attachment, the cord anchorage comprises one or more clamping members intended to be pressed by means of one or more nuts engaging with studs which are securely attached to the appliance, the cord anchorage is considered to have one part securely fixed to the appliance, even if the clamping members can be removed from the studs.

21.7.2 If, however, the clamping member(s) are intended to be pressed by means of one or more screws engaging either with separate nuts or with a thread in a part which is integral with the appliance, the cord anchorage is not considered to have the part securely fixed to the appliance, or the surface of the appliance is of insulating material and so shaped that it is obvious that this surface is one of the clamping members.

21.8 For Type X attachment, glands shall not be used as cord anchorages in portable appliances, unless they have provision for clamping all types and sizes of cables and cords which might be used as the power supply cord, and production methods, such as moulded-on designs, tying the cable or cord into a knot or tying the ends with string, are not allowed; labyrinths or similar means are permitted, provided that it is clear how the power supply cord is to be assembled.

21.8.1 For Type X attachment, cord anchorages shall be so designed or located that :

a) replacement of the cable or cord is easily possible;

b) it is clear how the relief from strain and the prevention of twisting are to be obtained;

c) they are suitable for the different types of cable or cord which may be connected, unless the appliance is so designed that only one type of cable or cord can be fitted;

d) the cable or cord cannot touch the clamping screws of the cord anchorage, if these screws are accessible or electrically connected to accessible metal parts;

e) the cord is not clamped by a metal screw which bears directly on the cord;

f) at least one part of the cord anchorage is securely fixed to the appliance;

g) screws, if any, which have to be operated when replacing the cable or cord, do not serve to fix any other component, unless, when omitted or incorrectly mounted, they render the appliance inoperative or clearly incomplete or unless the parts intended to be fastened by them cannot be removed without the aid of a tool during the replacement of the cable or cord; and

h) they are of insulating material or are provided with an insulating lining, if otherwise an insulation fault on the cable or cord could make accessible metal parts live.

21.9 For Type M attachment, the cores of the power supply cord shall be insulated from accessible metal parts by insulation complying with requirements of basic insulation. The insulation shall consist of :

a) a separate insulated barrier fixed to the cord anchorage,

b) a special sleeve or grommet fixed to the cable or cord, and

c) a sheath of a sheathed cable or cord.

NOTE — Grommet is an insulating washer placed around the electric connector passing through hole in metal.

21.9.1 For Type M attachment, cord anchorages shall be so designed that :

a) the replacement of the power supply cord does not impair compliance;

b) the cable or cord cannot touch clamping screws of the cord anchorage, if these screws are accessible or electrically connected to accessible metal parts;

c) the cable or cord is not clamped by a metal screw which bears directly on the cable or cord;

d) knots in the cord are not to be used; and

e) labyrinths or similar means are permitted, provided that it is clear how the power supply cord is to be assembled.

For Type M attachment, it is clear how the relief from strain and the prevention of twisting is to be obtained.

21.10 Compliance is checked by inspection and by the following test:

For Type X attachment, the appliance is fitted with a suitable power supply cord. The conductors are introduced into the terminals, the terminal screws, if any, being tightened just sufficiently to prevent the conductors from easily, changing their position. The cord anchorage is used in the normal way, its clamping screws being tightened with a torque equal to two-thirds of that specified in **24.1**.

The tests are first made with the lightest permissible type of cable or cord of the smallest cross-sectional area specified in **22.2** and then with the next heavier type of cable or cord of the largest cross-sectional area specified, unless the appliance is so designed that only one type of cable or cord can be fitted.

For Type M attachment, the appliance is tested with the cord in place.

It shall not be possible to push the cable or cord into the appliance to such an extent that the cable or cord, or internal parts of the appliance, could be damaged.

Cable or cord is then subjected 25 times to a pull of 30 N. The pulls are applied in the most unfavourable directions but without jerks, each times for one second.

Immediately afterwards, the cable or cord is subjected for one minute to a torque of 0.1 Nm.

21.10.1 During the test, the cable or cord shall not be damaged.

21.10.2 After the tests, the cable or cord shall not have been longitudinally displaced by more than 2 mm and the conductors shall not have moved over a distance of more than 1 mm in the terminals, nor shall there be appreciable strain at the connection.

21.10.3 Creepage distances and clearances shall not be reduced below the values specified in Table 2.

22 TERMINALS FOR EXTERNAL CONDUCTORS

22.1 Appliances, other than those provided with supply leads shall be provided with terminals in which connection is made by means of screws, nuts or equally effective devices.

Screws and nuts which clamp external conductors shall have ISO metric screw thread or a thread comparable in pitch and mechanical strength. They shall not serve to fix any other component, except that they may also clamp internal conductors if these are so arranged that they are unlikely to be displaced when fitting the supply conductors.

22.2 Terminals for Type X attachment shall allow the connection of conductor having nominal cross-sectional area given as below :

Rated Current of Appliance	*Nominal Cross-Sectional Area of Conductor of Flexible Cable*
Up to 3 A	0.5 to 0.75 mm^2
Over 3 and up to 10 A	0.75 to 1.5 mm^2

Compliance with the requirements of **22.1** and **22.2** is checked by inspection, by measurement and by fitting cables or cord of the smallest and largest cross-sectional areas specified.

22.3 Terminals for Type M attachment shall be suitable for their purpose.

Compliance is checked by inspection and by applying a pull to the connection of 5 N.

After the test, the temperature rise of the terminal or termination, determined under the conditions specified in **9.5** shall not exceed the value specified in Table 1.

22.4 Terminals shall be so fixed that, when the clamping means is tightened or loosened, the terminals does not work loose, internal wiring is not subjected to stress and creepage distances and clearances are not reduced below the values specified in Table 2.

Compliance is checked by inspection and by measurement after fastening and loosening ten times a conductor of the largest cross-sectional area specified in **22.2**, the torque applied being equal to two-thirds of the torque specified in **24.1**.

Terminals may be prevented from working loose by fixing with two screws, by fixing with one screw in a recess such that there is no appreciable play, or by other suitable means.

Covering with sealing compound without other means of locking is not considered to be sufficient. Self-hardening resins may, however, be used to lock terminals which are not subject to torsion in normal use.

22.5 Terminals of the pillar type shall have dimensions as shown in the following table, except that the length of the thread in the pillar may be reduced, if the mechanical strength is adequate and at least two full threads are in engagement when a conductor of the smallest cross-sectional area specified in **22.2** is tightly clamped:

Rated Current of Appliance	*Minimum Nominal Thread Diameter*	*Minimum Diameter of Hole for Conductor*	*Minimum Length of Thread in Pillar*	*Maximum Difference Between Diameter of Hole and Nominal Thread Diameter*
(1)	(2)	(3)	(4)	(5)
A	mm	mm	mm	mm
Up to and including 10	3.0	3.0	2.0	0.6

The length of the threaded part of the terminal screw shall not be less than the sum of the diameter of the hole for the conductor and the length of the thread in the pillar.

The surface against which the conductor is clamped shall be free from sharp indentations or projections.

Such terminals shall be so designed and located that the end of a conductor introduced into the hole is visible, or can pass beyond the threaded hole for a distance at least equal to half the nominal diameter of the screw, or 2.5 mm, whichever is the greater.

The length of the thread in the pillar is measured to the point where the thread is first broken by the hole for the conductor.

If the thread in the pillar is recessed, the length of headed screws must be increased accordingly.

The part against which the conductor is clamped need not necessarily be in one piece with the part carrying the clamping screw.

22.6 Stud-terminals shall be provided with washers and shall have dimensions as shown in the following table :

Rated Current of Appliances	*Nominal Diameter (Min)*	*Difference Between Thread Diameter and*	
		Inner Diameter of Washers *(Max)*	Outer Diameter of Washers *(Min)*
(1)	(2)	(3)	(4)
A	mm	mm	mm
Up to and including 10	3.0	0.4	4.0

Compliance with the requirements of **22.5** and **22.6** is checked by inspection, by measurement and, if necessary, by the tests of **22.7**. A negative deviation of 0.15 mm is allowed for the nominal thread diameter and for the nominal difference between diameters of head and shank of the screw.

If one or more of the dimensions required in **22.5** and **22.6** are larger than the specified, the other dimensions need not be correspondingly increased, but departures from the specified values must not impair the function of the terminal.

22.7 If the length of thread in the pillar, screw hole or nut, or the length of thread on the screw, is smaller than that shown in the relevant Table, or if the length of the extrusion is more than 80 percent of the original thickness of the metal, the mechanical strength of the terminal is checked by the following tests :

Screws and nuts are subjected to the test of **24.1** but with the torque increased to 1.2 times the torque specified.

After this test, the terminal shall show no damage impairing its further use.

A conductor is then fastened, as specified in **22.4** once more and while clamped, is subjected for 1 minute to an axial pull, applied without jerks, of the value shown below :

Rated Current of Appliance	*Pull*
A	N
Up to and including 10	50

During the test, the conductor shall not move noticeably in the terminal.

22.8 For appliances, with Type X and Type M attachments, each terminal shall be located in proximity to its corresponding terminal, or terminals, of different polarity and to the earthing terminal, if any.

Compliance is checked by inspection.

22.9 Terminal devices shall not be accessible without the aid of a tool, even if their live parts are not accessible.

Compliance is checked by inspection and by manual test.

22.10 Terminal devices of appliances with Type X attachment shall be so located or shielded that should a wire of a stranded conductor escape when the conductors are fitted, there is no risk of accidental connection between live parts and accessible metal parts.

Compliance is checked by the following test :

An 8 mm length of insulation is removed from the end of a flexible conductor having a nominal cross-sectional area as specified in **21.3.4**. One wire of the stranded conductor is left free and the other wires are fully inserted into and clamped in the terminal.

The free wire is bent, without tearing the insulation back, in every possible direction, but without making sharp bends round barriers.

The free wire of a conductor connected to a live terminal shall not touch any metal part which is accessible or is connected to an accessible metal part. The free wire of a conductor connected to an earthing terminal shall not touch any live part.

23 PROVISION FOR EARTHING

23.1 Accessible metal parts of appliances, which may become live in the event of an insulation fault, shall be permanently and reliably connected to an earthing terminal or termination within the appliance, or to the earthing contact of the appliance inlet.

Earthing terminals and earthing contacts shall not be electrically connected to the neutral terminal.

23.2 Earthing terminals of appliances with Type X and Type M attachments shall comply with the requirements of **22**.

Screwless terminals shall not be used for the connection of external earthing conductors.

External earthing terminals, if any, shall allow the connection of conductors having nominal cross-sectional areas of 2.5 to 6 mm^2.

The clamping means of earthing terminals shall be adequately locked against accidental loosening and it shall not be possible to loosen them without the aid of a tool.

Compliance is checked by inspection, by manual test and by the tests of **22**.

In general, the designs commonly used for current carrying terminals, other than some terminals of the pillar type, provide sufficient resiliency to comply with the latter requirement; for other designs, special provisions, such as the use of an adequately resilient part which is not likely to be removed inadvertently, may be necessary.

23.3 If detachable parts have an earth connection, this connection shall be made before the current carrying connections are established when placing the part in position, and the current carrying connections shall be separated before the earth connection is broken when removing the part.

For appliances with power supply cords, the arrangement of the terminals, or the length of the conductors between the cord anchorage and the terminals, shall be such that the current carrying conductors become tight before the earthing conductor, if the cable or cord slips out of the cord anchorage.

23.4 All parts of the earthing terminal shall be such that there is no risk of corrosion resulting from contact between these parts and the copper of the earthing conductor, or any other metal that is in contact with these parts.

The body of the earthing terminal shall be of brass or other metal no less resistant to corrosion, unless it is a part of the metal frame or enclosure, when the screw or nut shall be of brass, plated steel complying with **27**, or other metal no less resistant to corrosion.

If the body of the earthing terminal is a part of frame or enclosure of aluminium or aluminium alloy, precautions shall be taken to avoid the risk of corrosion resulting from contact between copper and aluminium or its alloys.

Screws and nuts of plated steel withstanding the test of **27.1** are considered to be of a metal no less resistant to corrosion than brass.

23.5 The connection between the earthing terminal or earthing contact, and parts required to be connected thereto, shall be of low resistance.

Compliance is checked by the following test :

A current derived from an ac source having a no-load voltage not exceeding 12 V, and equal to 1.5 times the rated current of the appliance or 25 A, whichever is the greater, is passed between the earthing terminal or earthing contact, and each of the accessible metal parts in turn.

The voltage drop between the earthing terminal of the appliance or the earthing contact of the appliance inlet, and the accessible metal part is measured, and the resistance calculated from the current and this voltage drop.

In no case shall the resistance exceed 0.1 Ω.

The resistance of the flexible cable or cord is not included in the resistance measurement.

Care is taken that the contact resistance between the tip of the measuring probe and the metal part under test does not influence the test results.

24 SCREWS AND CONNECTIONS

24.1 Screwed connections, electrical or otherwise, shall withstand the mechanical stresses occurring in normal use.

Screws transmitting contact pressure and screws which are likely to be tightened by the user and have a nominal diameter less than 3 mm, shall screw into metal.

Screws shall not be of metal which is soft or liable to creep, such as zinc or aluminium.

Screws of insulating material shall have a nominal diameter of at least 3 mm; they shall not be used for any electrical connection.

Screws shall not be of insulating material if their replacement by a metal screw could impair supplementary insulation or reinforced insulation, neither shall screws which may be removed when replacing a power supply cord or undertaking other routine servicing, be of insulating material if their replacement by a metal screw could impair basic insulation.

Compliance is checked by inspection and, for screws and nuts transmitting contact pressure, or which are likely to be tightened by the user, by the following test.

'The screws or nuts are tightened and loosened :

10 times for screws in engagement with a thread of insulating material, and

5 times for nuts and other screws.

Screws in engagement with a thread of insulating material are completely removed and reinserted each time.'

When testing terminal screws and nuts, a conductor of the largest cross-sectional area specified in **22.2** is used.

The test is made by means of a suitable test screwdriver, spanner or key, applying a torque as shown in the following table, the appropriate column being :

Col I For metal screws without heads if the screw when tightened does not protrude from the hole.

Col II For other metal screws and for nuts; and

For screws of insulating material :

a) having a hexagonal head with the dimension across flats exceeding the overall thread diameter; or
b) with a cylindrical head and a socket for a key, the socket having cross-corner dimension exceeding the overall thread diameter; or
c) with a head having a slot or cross slots, the length of which exceeds 1.5 times the overall threads diameter.

Col III For other screws of insulating material.

Nominal Diameter of Screw mm	*Torque*, Nm		
	Col I	Col II	Col III
Up to and including 2.8	0.2	0.4	0.4
Over 2.8 up to and including 3.0	0.25	0.5	0.5
Over 3.0 up to and including 3.2	0.3	0.6	0.6

The conductor is moved each time the screw or nut is loosened.

During the test, no damage impairing the further use of the screwed connections shall occur.

Screws or nuts which are likely to be tightened by the user include screws intended to be operated when replacing the power supply cord.

The shape of the blade of the test screwdriver must suit the head of the screw to be tested. The screws and nuts must not be tightened in jerks.

24.2 Screws in engagement with a thread of insulating material shall have a length of engagement sufficient to ensure a reliable connection.

Correct introduction of the screw into the screw hole or nut shall be ensured.

Compliance is checked by inspection and by the test of **24.1**, the torque applied being, however, increased to 1.2 times the torque specified.

The requirement with regard to correct introduction is met if introduction of the screw in a slanting manner is prevented, for example, by guiding the screw by the part to be fixed, by a recess in the female thread or by the use of a screw with the leading thread removed.

24.3 Electrical connections shall be so designed that contact pressure is not transmitted through insulating material which is liable to shrink or distort, unless there is sufficient resiliency in the metallic parts to compensate for any possible shrinkage or distortion of the insulating material.

Ceramic material is not liable to shrink or to distort.

24.4 Space-threaded (sheet metal) screws shall not be used for the connection of current carrying parts, unless they clamp these parts directly in contact with each other and are provided with a suitable means of locking.

Thread-cutting (self tapping) screws shall not be used for the electrical connection of current carrying parts, unless they generate a full form standard machine screw thread. Such screws shall not, however, be used if they are likely to be operated by the user or installer unless the thread is formed by a swageing action.

Thread-cutting and space-threaded screws may be used to provide earthing continuity, provided that it is not necessary to disturb the connection in normal use and that at least two screws are used for each connection.

Compliance with the requirements of **24.3** and **24.4** is checked by inspection.

24.5 Screws which make a mechanical connection between different parts of the appliance, shall be secured against loosening, if the connection carries current.

Rivets used for current carrying connections shall be secured against loosening if these connections are subject to torsion in normal use.

Compliance is checked by inspection and by manual test.

The first requirement does not apply to screws in the earthing circuit, provided there is an alternative earthing circuit.

Spring washers and the like may provide satisfactory security.

For rivets, a non-circular shank or an appropriate notch may be sufficient. Sealing compound which softens on heating provides satisfactory security only for screw connections not subject to torsion in normal use.

25 CREEPAGE DISTANCES AND CLEARANCES

25.1 Creepage distances and clearances shall not be less than the values in millimetres shown in Table 2.

Compliance is checked by measurements.

NOTES

1 The way in which creepage distances and clearances are measured is indicated in Annex F.

2 If barrier is interposed and if it is in two parts which are not cemented together, the creepage distance is also measured through the joint.

3 If a barrier is interposed, clearances are measured over the barrier or, if the barrier is in two parts with mating surfaces which are not cemented together, through the joint.

26 RESISTANCE TO HEAT, FIRE AND TRACKING

26.1 External parts of insulating material, the deterioration of which might cause the appliance to fail to comply with this standard, shall be sufficiently resistant to heat.

Compliance is checked by subjecting enclosures and other external parts of insulating material to a ball pressure test by means of the apparatus shown in Fig. 7.

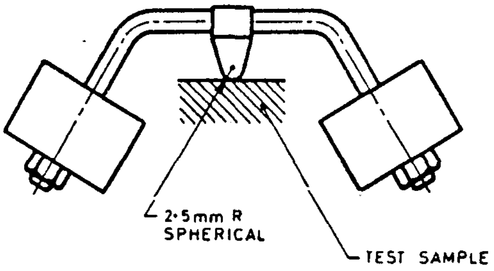


FIG. 7 BALL PRESSURE APPARATUS

The surface of the part to be tested is placed in the horizontal position and a steel ball of 5 mm diameter is pressed against this surface by a force of 20 N.

Table 2 Creepage Distances and Clearances for Appliance Rated up to 250 V

(*Clause* 25.1)

Sl No.	Part	Distances mm	
		Creepage	Clearance
(1)	(2)	(3)	(4)
i)	Between live parts of different polarity[1]	3.0	2.5
ii)	Between live parts and other metal parts over basic insulation	4.0	3.0
iii)	Between live parts in recesses in the mounting face of the appliance and the surface to which it is fixed	6.0	6.0

[1] The clearances given above do not apply to the air gap between contacts of the thermostats, thermal cut-outs or temperature control devices or micro-switches.

The test is made in a heating cabinet at a temperature of 75 ± 2°C or at a temperature which is 40 ± 2°C in excess of the temperature-rise of the relevant part determined during the test of **15**, whichever is the higher.

After 1 hour, the ball is removed from the sample which is thus cooled down within 10 seconds to approximately room temperature by immersion in cold water. The diameter of the impression caused by the ball is measured. This shall not exceed 2 mm.

The test is not made on parts of ceramic material.

26.2 Insulating parts retaining live parts in position shall be resistant to abnormal heat and to fire.

Compliance is checked by the following test :

A test is made as described in **26.1** but at a temperature of 125 ± 2°C or at a temperature which is 40 ± 2°C in excess of the temperature-rise of the relevant part determined during the test of **9** whichver is higher.

In addition, the insulating parts are subjected to a test made with an electrically heated conical mandrel in an apparatus as shown in Fig. 8.

The mandrel is inserted into a conical hole reamed in the part to be tested in such a way that portions of the conical part of the mandrel of equal length protrude from both sides. The sample is pressed against the mandrel with a force of 12 N. The means by which the force is applied is then locked to prevent any further movement. However, if the sample starts to soften or to melt during the test, a force just sufficient to keep the sample in contact with the mandrel is applied to the sample in the horizontal direction.

The mandrel is heated to a temperature of 300°C in approximately 3 minutes and is maintained within 10°C of this value for 2 minutes. The temperature is measured by means of a thermocouple inside the mandrel.

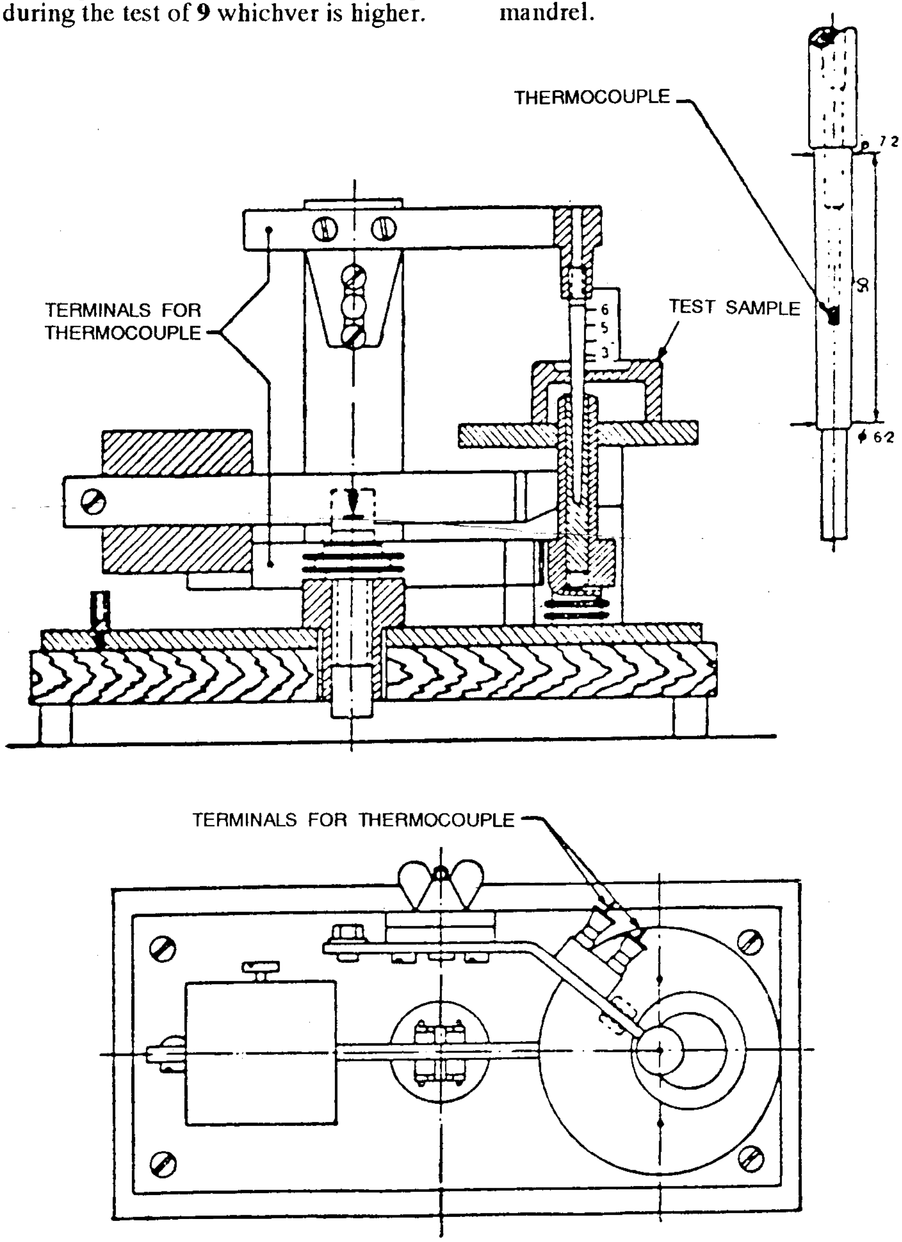


FIG. 8 HOT MANDREL APPARATUS

During the period of 5 minutes, sparks of about 6 mm in length are produced at the upper surface of the sample where the mandrel protrudes and the sample is in contact with the mandrel. The sparks are produced by means of a high frequency generator, the electrodes of which are moved around the mandrel so as to cover the whole area of the sample near the mandrel.

Neither the sample, nor any gases produced during the heating shall be ignited by the sparks.

The tests are not made on parts of ceramic material.

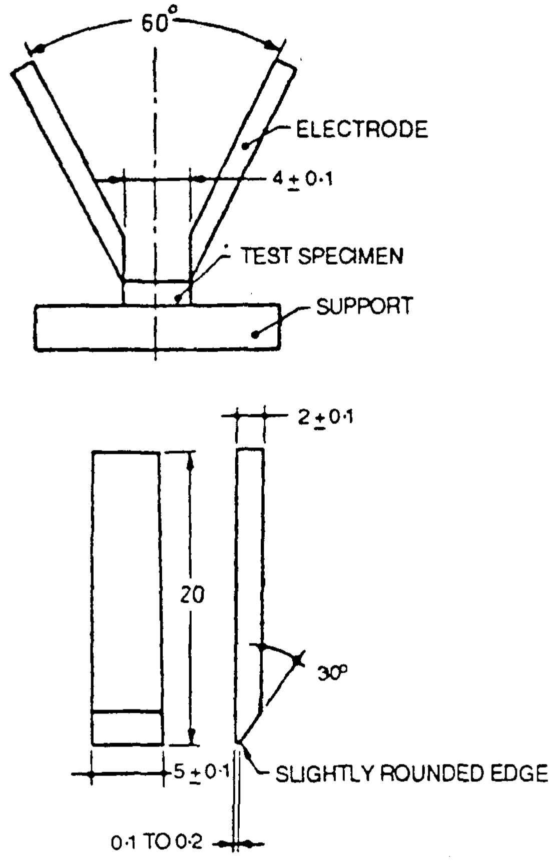
26.3 Alternative method is given in Annex G.

26.4 Insulating parts retaining live parts in position shall be of material resistant to tracking, if they are exposed to excessive deposition of moisture or dirt in normal use, unless the creepage distances are at least equal to twice the values specified in **25.1**.

For materials other than ceramic, compliance is checked by the following test :

'A flat surface of the part to be tested, if possible at least 15 mm x 15 mm, is placed in the horizontal position.

Two electrodes of platinum or other sufficiently non-corrodable material, with the dimensions shown in Fig. 9 are placed on the surface of the sample in the manner shown in this figure, so that the rounded edges are in contact with the sample over their whole length.



All dimensions in millimetres.

Fig. 9 Arrangement and Dimensions of the Electrodes for the Tracking Test

The force exerted on the surface by each electrode is about 1 N.

The electrodes are connected to a 50 Hz supply such that the no-load voltage is of substantially sine-wave form and has a value of 175 V, which shall not be reduced by more than 17.5 V when the electrodes are short-circuited. The total impedance of the circuit when the electrodes are short-circuited is adjusted by means of a variable resistor, so that the current is equal to 1.0 ± 0.1 A with a power factor between 0.9 and 1. An overcurrent relay is included in the circuit, the relay being so designed that, when the current has reached a value of 0.5 A, the circuit is interrupted after a period which is, as short as possible, but not less than 2 seconds.

The surface of the sample is wetted by allowing drops of a solution of ammonium chloride in distilled water to fall centrally between the electrodes. The solution has a volume resistivity of 400 Ω cm at 25°C, corresponding to a concentration of about 0.1 percent. The drops have a volume of 20^{+5}_{-0} mm^3 and fall from a height of 30 mm to 40 mm.

The time interval between one drop and the next is 30 ± 5 seconds.

No flashover or breakdown between electrodes shall occur before a total of 50 drops has fallen.'

The test is made at three places on the sample.

Care is taken that the electrodes are clean, correctly positioned before each test is started.

In case of doubt, the test is repeated, if necessary on a new sample. The test is not made on insulating parts of commutators or brush-caps.

27 RESISTANCE TO RUSTING

27.1 Ferrous parts, the rusting of which might cause the appliance to fail to comply with this standard, shall be adequately protected against rusting.

Compliance is checked by the following test:

'All grease is removed from the parts to be tested by immersion in carbon tetrachloride or trichloroethane for 10 minutes.

The parts are then immersed for 10 minute in a 10 percent solution of ammonium chloride in water at a temperature between 15°C and 35°C.'

Without drying, but after shaking off any drops, the parts are placed for 10 minutes in a box containing air, shaking not less than 90 percent RH and temperature between 15°C and 35°C.

After the parts have been dried for 10 minute in a heating cabinet at a temperature of 100 ± 5°C, their surfaces shall show no signs of rust.

Traces of rust on sharp edges and any yellowish film removed by rubbing are ignored.

For small helical springs and the like, and for parts exposed to abrasion, a layer of grease may provide sufficient protection against rusting. Such parts are only subjected to the test if there is doubt about the effectiveness of the grease film, and the test is then made without previous removal of the grease.

28 FINISH

28.1 The external finished used on metal components shall be of a heat and moisture — resisting nature and shall not be adversely affected by variations in temperature occurring under normal operating conditions or after the endurance test.

Compliance shall be checked by visual inspection after endurance test.

29 THERMAL EFFICIENCY

29.1 When tested in accordance with **29.2**, the thermal efficiency shall not be less than 65 percent.

29.1.1 In case the efficiency marked on the electric stove is higher than 65 percent, a tolerance of (–) 10 percent shall be allowed on this value subject to the provision that the actual efficiency shall in no case fall below 65 percent.

29.2 Test for Thermal Efficiency

29.2.1 The electric stove shall be mounted 200 mm above a wooden supporting surface on heat insulated supports. It shall be shielded by a suitable antidraught screen which should be of a height extending from the test table to the top of test vessel. The screen should not be allowed to induct the draught by acting as a chimney. The supports shall be arranged to provide maximum of free space under the stove.

The test vessel conditioned as per **2.20** shall be used for the test.

29.2.2 *Test Procedure* — The test vessel containing 1.5 litres per kilowatt rating of the appliance, of water shall be placed centrally on the stove. The initial temperature of the water shall be noted. The stove shall be connected to the source of supply, the circuit having been adjusted to give rated input. During the heating up period, water shall be continuously stirred and its temperature measured. When the water temperature is nearly 50°C above the initial temperature of the water, its temperature T_2°C just prior to the addition of an extra quantity of water as specified in **29.2.2.1** shall be accurately noted.

29.2.2.1 A quantity of water equal to 0.75 litre per kilowatt rating of the appliance whose actual mass M in kg and initial average temperature T_1°C are accurately known, shall then be poured into the test vessel, and the heating continued, measurement of electrical input energy in kilowatt-hours having begun from this instant. The heating and stirring shall be continued till the whole mass of water again reaches the temperature T_2°C when the measurement of input energy shall be discontinued. The electrical energy consumed during this period E in kilowatt-hours is noted.

The test shall be repeated with the test vessel rotated through 180° relative to the position in the first test.

29.3 Calculation of Thermal Efficiency

The thermal efficiency, which is the ratio of heat absorbed by water to the heat equivalent of electrical energy supplied expressed as a percentage shall be computed as follows :

$$\text{Thermal efficiency} = \frac{MS\,(T_2 - T_1)}{860 \times E} \times 100$$

where

M = mass of water added in kg,

S = specific heat of water in cal/deg C,

T_2 = final temperature of the water,

T_1 = initial temperature of the water,

E = electrical energy input, and

860 = heat equivalent of 1 kWh of electrical energy.

ANNEX A

(*Clause* 4.1)

CATEGORIES OF TESTS

A-0 The tests on appliances are classified as type, acceptance and routine tests (*see* **2.34**, **2.35** and **2.36**).

A-1 The tests listed in this annexure should preferably be carried out in the order of the clauses referred against the tests.

A-2 TYPE TEST

The tests specified in Table 3 shall constitute the type tests and shall be carried out on two samples of electric stoves of the same type and rating selected preferably at random from a regular production lot. Before commencement of the tests, the electric stoves shall be visually examined and inspected for obvious visual defects in respect of components, parts and their assembly, construction stability, markings, provision of suitable terminals for supply connections, earthing and the effectiveness of screws and connections. The external surface finish shall be even and free from finishing defects.

A-2.1 Criteria of Acceptance

Both samples shall successfully pass all the type tests for proving conformity. If any of the samples fails in any of the type tests, the testing authority, at its discretion, may call for fresh samples not exceeding twice the original number and subject them again to all tests or to the test(s) in which failure(s) had occurred. No failure should be permitted in the repeat test(s).

A-3 ACCEPTANCE TESTS

The following shall constitute the acceptance tests:

Tests	*Clause Reference*
a) Protection against electric shock	7
b) Input	8
c) Temperature-rise	9
d) Electric insulation and leakage current as operating temperature	11
e) Moisture resistance	12
f) Insulation resistance and electric strength (after humidity treatment)	13
g) Earthing connection	23
h) Performance (Thermal Efficiency)	29

A-3.1 A recommended sampling procedure for acceptance tests is given in Annex C.

A-4 ROUTINE TESTS

The following shall constitute the routine tests :

Test	*Clause Reference*
a) Protection against electric shock	7
b) High voltage	11.3.2
c) Earthing connections	23.5

Table 3 Schedule of Type Tests

(*Clause* A-2)

Sl No. (1)	Test (2)	Clause Reference (3)
1.	Protection against electric shock	7
2.	Input	8
3.	Temperature-rise	9
4.	Operation under overload conditions	10
5.	Electrical insulation and leakage current at operating temperature	11
6.	Moisture resistance	12
7.	Insulation resistance and electric strength (after humidity treatment)	13
8.	Thermal efficiency	29
9.	Thermal controls (if provided)	—
10.	Endurance	14
11.	Abnormal operation	15
12.	Stability and mechanical hazards	16
13.	Mechanical strength	17
14.	Cord grip and cord guard	21
15.	Provision for earthings	23
16.	Screws and connections	24
17.	Creepage distances and clearances	25
18.	Resistance to heat, fire and tracking	26
19.	Resistance to rusting	27

ANNEX B

(*Clause* 4.9)

LIST OF TEST EQUIPMENT FOR ELECTRIC STOVES

1. Electrical measuring instruments :
   - a) Voltmeter, Range 0 to 300 V, ac, accuracy Class 1 of IS 1248 (Part 1) : 1983
   - b) Milli-voltmeter, Range 0 to 3 V, ac, accuracy Class 1 of IS 1248 (Part 1) : 1983
   - c) Wattmeter, Range 0 to 3 kW, ac, accuracy Class 1 of IS 1248 (Part 2) : 1983

     Ammeter, Range 0 to 15 A, accuracy Class 1, of IS 1248 (Part 1) : 1983
   - d) Milli-ammeter, Range 0 to 3 mA, ac, accuracy Class 1, of IS 1248 (Part 1) : 1983
2. Fixed resistance of 2 000 ohm for leakage current test.
3. Stop watch — least count 1 minute, *Min.*
4. Continuous variable auto transformer, input 240 V, output 0 to 270 V, ac, current rating 15 A (3 in Number; 2 for Endurance, 1 for other tests).
5. Two winding isolating safety transformer input 240 V, output 240 V with centre tapping unity ratio; 3 kVA rating.
6. Two windings step down transformer input 240 V, output 40 V, 12 V, current capacity 30 A for earthing connections and safety against contact of live parts.
7. High voltage test set, input 240 V, output variable 0 to 5 kV, provided with leakage current tripping relay.
8. Test finger, test pins and test probe as per Fig. 1, 2 & 3.
9. Blackened test corner of wood with wooden flooring and fitted with thermocouple on two sides and the temperature measuring instrument/thermometers (*see* **9**).
10. Impact test apparatus spring operated (Fig. 6) or pendulum type (Fig. 10).
11. Cord grip test apparatus and apparatus for torque test on cord grip; if provided on appliance.
12. Flexing test apparatus for cord guard, if provided (*see* **21**).
13. Ball pressure test apparatus (*see* Fig. 7).
14. Electric laboratory oven, double walled and insulated. Temperature control within 1°C, temperature range up to 200°C.
15. Humidity chamber, capable to maintain temperature up to 100°C and relative humidity of 90 percent and above.
16. Aluminium foil for test of leakage current and dielectric strength.
17. Magnifying glass for detection of cracks in insulation after impact test (**17**).
18. Vernier calliper, filler gauges for measuring clearances and creepage distance (**25**).
19. Rubber insulated safety gloves for operator.
20. Rubber mat for flooring of testing area.
21. Insulation resistance tester (meggar) (optional) - 500 V dc hand operated or electronic, accuracy 5 or 10 percent.
22. Tracking index test apparatus (Fig. 9).
23. Hot mandrel apparatus (Fig. 8) or
    Ignition test apparatus (Fig. 11).
24. Test screw drivers for torque test on screws and nuts.
25. Inclined plane.
26. Watt hour meter - 5/10 A, 240 V, 50 Hz, Single phase, Accuracy 1 percent of IS 722 (Part 8) : 1972
27. Flat bottomed vessel of aluminium or copper of appropriate diameter to cover heating area of the stove.
28. Standard volumetric measures including glass cylinder for measurement of volume of liquids during thermal efficiency test.
29. Hardened steel ball of 75 mm for mechanical shock test.
30. Steel plate of 3 mm thick having size to cover the top of the heating area.

ANNEX C

(Clause 9.3)

MEASUREMENT OF TEMPERATURE

C-1 METHODS OF MEASUREMENT

C-1.1 Two methods as applied to radiators for temperature measurement are described in this annex, namely:

a) thermometer method, and

b) thermocouple method.

C-1.1.1 Of these methods the latter is more accurate methods recognized for reference purposes.

C-2 THERMOMETER METHOD

C-2.1 Any of the following three types of thermometers may be employed :

a) Bulb thermometer containing mercury,

b) Bulb thermometer containing alcohol, or

c) Resistance thermometer.

C-2.1.1 Mercury-in-bulb thermometer is ineffective where it is subject to the action of alternating magnetic fields, owing to consequent heating of the mercury by the eddy currents which are induced in it. The effectiveness of resistance thermometer in such applications depends on the construction of the instrument.

C-2.1.2 Where bulb thermometers are used to measure the temperature of a surface, either of the following procedures may be adopted, whichever is appropriate to the particular case:

a) The bulb shall be surrounded by a single wrapping of tin-foil having a thickness of not less than 0.025 mm. The foil shall be turned up at the end to form a complete covering for the bulb, which shall then be secured in contact with surface under test. The exposed part of the wrapped bulb shall then be completely covered with a pad of heat-insulating material without unduly shielding the test surface from normal cooling.

b) The bulb, except at the point of contact, shall be covered with a pad of felt, cotton-wool, or other non-conducting material of thickness not less than 3.0 mm, extending at least 20 mm in every other direction from the bulb and pressed into contact with the surface to which it is applied to prevent loss of heat by radiation and convection from the bulb. It shall be ensured that the non-conducting material does not interfere unduly with the normal cooling of the test surface.

C-2.1.3 Any thermometer used shall be of marked immersion and known accuracy.

C-3 THERMOCOUPLE METHOD

C-3.1 The two conductors between which the thermoelectric effect is produced shall be welded or hard-soldered at both the hot and the cold junctions, care being taken to ensure that the wires at the junction make contact, at one point or the other, and are not twisted together (*see also* IS 2053 : 1962).

C-3.2 Thermocouples shall be affixed in a manner appropriate to the case, for example, by tying, clamping, welding or soldering. The hot junction shall be secured in position by means of a clip or pellet or solder, taking care that any adjustment of the junction or part to which it is applied, are not impaired thereby. Thermocouple circuit shall be earthed to minimize the effect of capacity currents except where it is applied to live parts. Where a thermocouple is soldered to a portion of the appliance, under test, care should be taken to avoid appreciably modifications of the physical characteristics of the appliance by the temperature of the fluxes used in the soldering process. Calibrated meter attached to the thermocouple shall give directly the temperature of the surface measured.

C-3.2.1 If the potentiometer is not equipped with cold junction compensation, the cold junction should be contained in a vaccum flask containing crushed ice.

ANNEX D

(*Clause* 17.1)

IMPACT TEST APPARATUS

D-1 DESCRIPTION FOR THE APPARATUS

D-1.1 A typical impact apparatus is shown in Fig. 10.

D-1.2 The striking element has a hemispherical face of radius 10 mm made of hardwood, polyamide or similar material weighing 0.15 kg. It is rigidly fixed to the lower end of a steel tube with an external diameter of 9 mm and thickness 0.5 mm which is pivoted at its upper end in such a way that it swings only in the vertical plane of the axis of the striking element. The axis of the pivot is 1 m above the axis of the striking element. The design of the apparatus is such that a force between 1.0 N and 2.0 N has to be applied to the face of the hammer to maintain the pendulum in a horizontal position.

D-1.3 The appliance is held against a solid wall of bricks, concrete or the like, and the test apparatus is so arranged that the pivot of the pendulum is vertically above the point of impact of the hammer. The striking element is then allowed to fall from such a height of 250 mm. Three such blows are applied to every part of the enclosure which is likely to be weak, including handles, levers and the like, but excluding signal lamps and their covers if these do not protrude from the enclosure by more than 3 mm or have a surface not exceeding 3 cm^2. Lamps within an appliance and their covers are tested only if they are likely to be damaged in normal use.

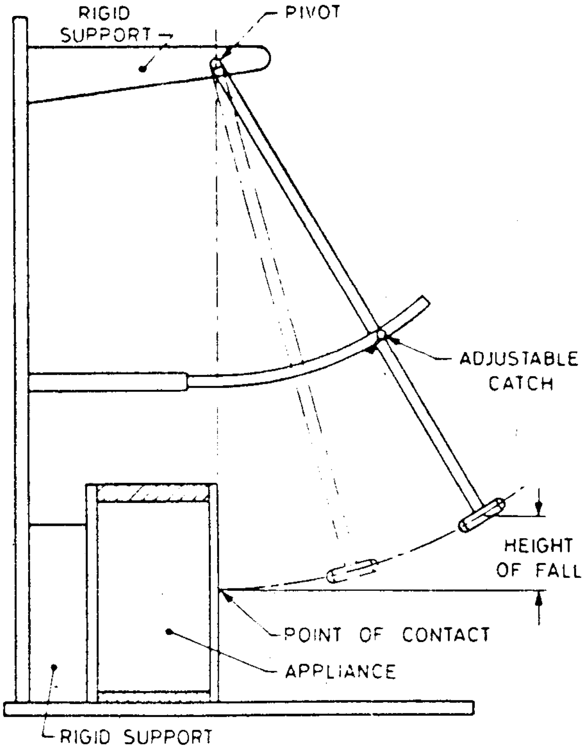


FIG. 10 APPARATUS FOR IMPACT TEST

ANNEX E

(*Clause* 20.1)

THERMAL CONTROLS AND OVERLOAD RELEASES

E-1 Thermal cutouts and overload releases shall operate reliably.

Compliance is checked by operating the appliance under the appropriate conditions specified in **15**.

Self-resetting thermal cutouts and overload releases are caused to operated 200 times; non-self-resetting thermal cutouts and overload releases are reset after each operation and thus caused to operated ten times. After the tests, the samples shall show no damage impairing their further use.

Forced cooling and resetting periods may be introduced to prevent damage to the appliance.

E-2 Thermostats, thermal cutouts and overload releases shall be so constructed that their setting is not changed appreciably by heating, vibration, etc, occurring in normal use.

Compliance is checked by inspection during the tests of **15**.

ANNEX F

(*Clause* 25.1)

MEASUREMENT OF CREEPAGE DISTANCES AND CLEARANCES

The methods of measuring creepage distances and clearances to be used in interpreting the requirements of **25.1** are indicated in Cases 1 to 10 of this Annex.

These cases do not differentiate between gaps and grooves or between types of insulation.

The following assumptions are made :

a) A groove may have parallel, converging or diverging sides.

b) Any groove having diverging sides, a minimum width exceeding 0.25 mm, a depth exceeding 1.5 m and a width at the bottom equal to or greater than 1 mm, is regarded as an air gap (*see* Case 8).

c) Any corner including an angle less than 80° is assumed to be bridged with an insulating link of 1 mm width (0.25 mm for dirt-free situations) moved into the most unfavourable position (*see* Case 3).

d) Where the distance across the top of a groove is 1 mm (0.25 mm for dirt-free situations) or more, no creepage distance exists across the air space (*see* Case 2).

e) A creepage path is assumed not to exist if there is an air gap as defined in item (b) above exceeding 0.25 mm.

f) Creepage distances and clearances measured between parts moving relative to each other are measured when these parts are in their most unfavourable stationary positions.

g) A computed creepage distance is never less than a measured clearance.

h) Any air gap less than 1 mm wide (0.25 mm for dirt-free situations) is ignored in computing the total clearance.

In the illustrations :

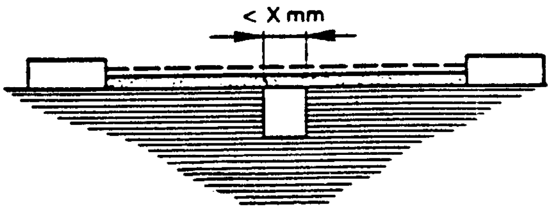
▤ indicates insulating material,

▭ indicates conducting parts,

------ indicates clearance, and

▨ indicates creepage distance.

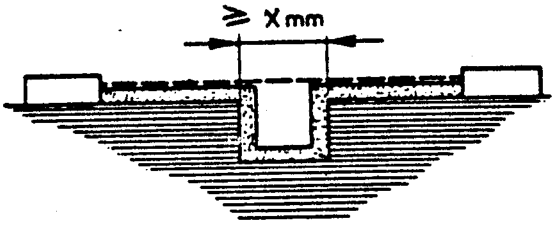
Case 1



Condition — Path under consideration includes a parallel or converging-sided groove of any depth with a width less than $X = 1$ mm.

Rule — Creepage distance and clearance are measured directly across the groove as shown.

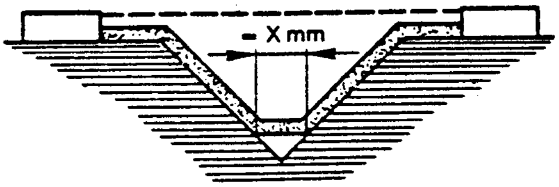
Case 2



Condition — Path under consideration includes a parallel-sided groove of any depth and equal to or more than $X = 1$ mm .

Rule — Clearance is the 'line of sight' distance. Creepage path follows the contour of the groove.

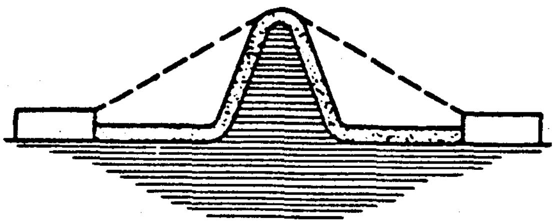
Case 3



Condition — Path under consideration includes a V-shaped groove with a width greater than $X = 1$ mm.

Rule — Clearance is the 'line of sight' distance. Creepage path follows the contour of the groove but 'short-circuits' the bottom of the groove by $X = 1$ mm.

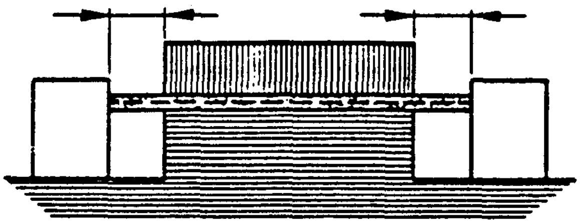
Case 4



Condition — Path under consideration includes a rib.

Rule — Clearance is the shortest direct air path over the top of the rib. Creepage path follows the contour of the rib.

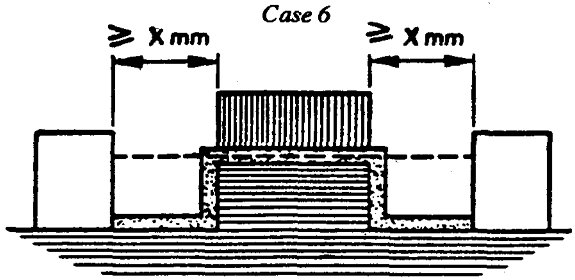
Case 5



Condition — Path under consideration includes and uncemented joint with grooves less than $X = 1$ mm wide on each side.

Rule — Creepage and clearance path is the 'line of sight' distance shown.

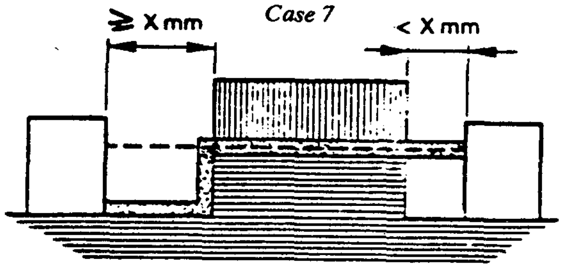
Case 6



Condition — Path under consideration includes an uncemented joint with grooves equal to or more than $X = 1$ mm wide on each side.

Rule — Clearance is the 'line of sight' distance. Creepage path follows the contour of the grooves.

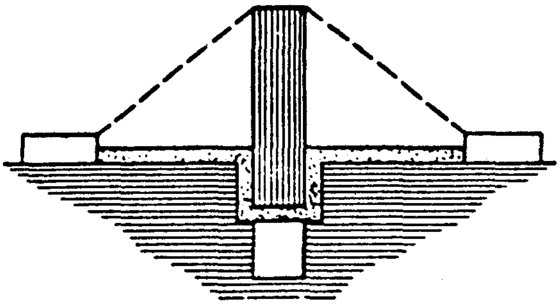
Case 7



Condition — Path under consideration includes an uncemented joint with a groove on one side less than $X = 1$ mm wide and the groove on the other side equal to or more than $X = 1$ mm wide.

Rule — Clearance and creepage paths are as shown.

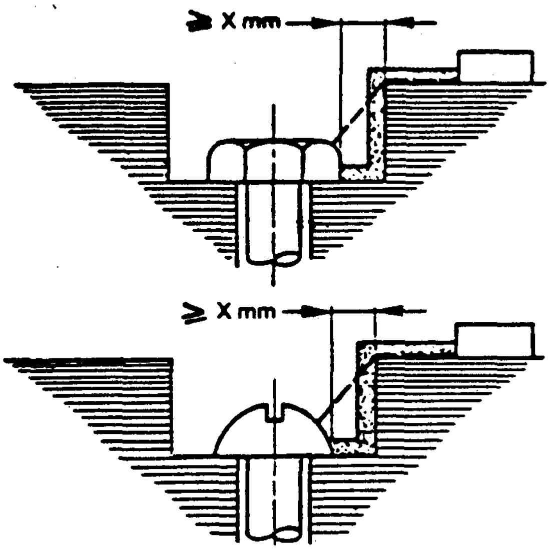
Case 8



Condition — Creepage distance through uncemented joint is less than creepage distance over barrier.

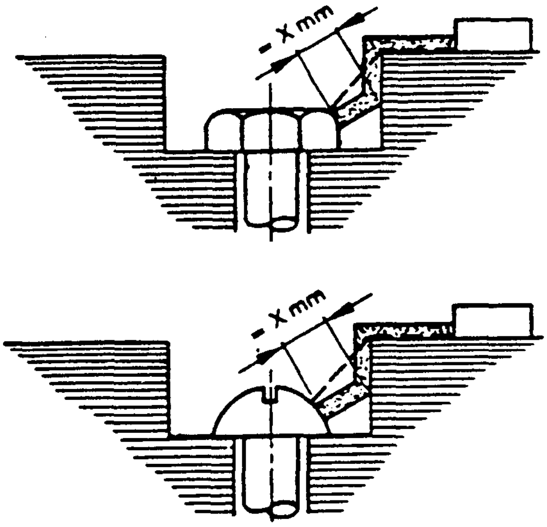
Rule — Clearance is the shortest direct air path over the top of the barrier.

Case 9



Gap between head of screw and wall of recess wide enough to be taken into account.

Case 10



Gap between head of screw and wall of recess too narrow to be taken into account. Measurement of creepage distance is from screw to wall when the distance is equal to $X = 1$ mm.

ANNEX G

(*Clause* 26.3)

TEST FOR FIRE-RESISTING PROPERTIES

G-1 PREPARATION OF SAMPLE

G-1.1 The specimen shall consist of a portion broken from the moulding and shall weigh not less than 6 g nor more than 10 g, and shall be nor more than 10.0 mm in thickness measured from an externally cured face.

G-2 APPARATUS

G-2.1 The specimen shall be tested in the heating tube of an apparatus of the general type, shown in Fig. 11, the pilot flame being located 20 mm above the upper end of the specimen.

G-2.2 A support for the specimen shall be provided in the heating tube and this may suitably consist of a light stirrup of nichrome wire, supported by a length of nichrome wire passing over the pilot flame tube. The support shall be such that the specimen is fixed centrally in the heating tube, with its largest dimension vertical.

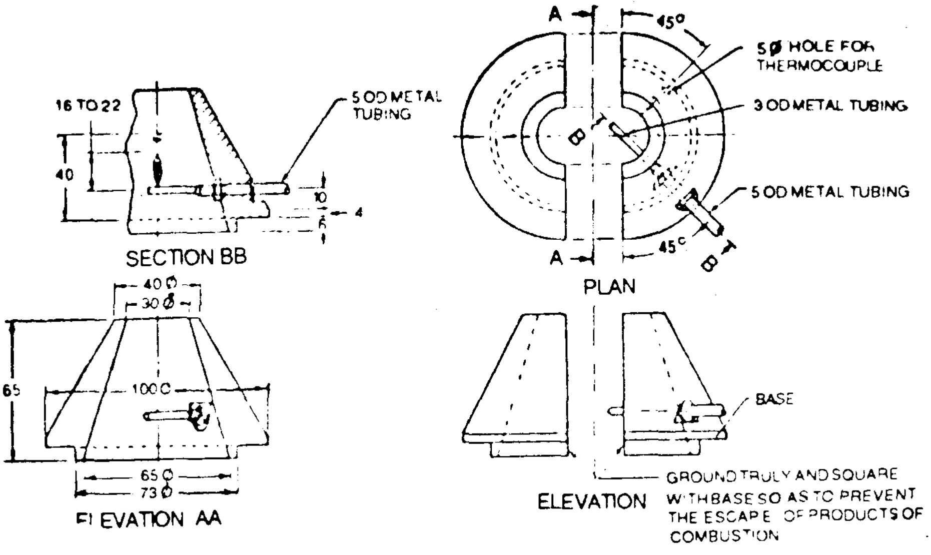
G-2.3 The apparatus shall be heated by passing a suitably regulated electric current through a nichrome resistance wire surrounding the heating tube.

G-2.4 Measurement of Temperature of Tube

The temperature of the tube shall be taken as shown by a thermocouple situated at the level of the centre of the specimen and equidistant from the inner surface of the heating tube and the specimen. The wires of which the thermocouple is made shall be not larger than 1.25 mm and not smaller than 0.462 mm in diameter and shall be bare for a length of 25 mm from the junction.

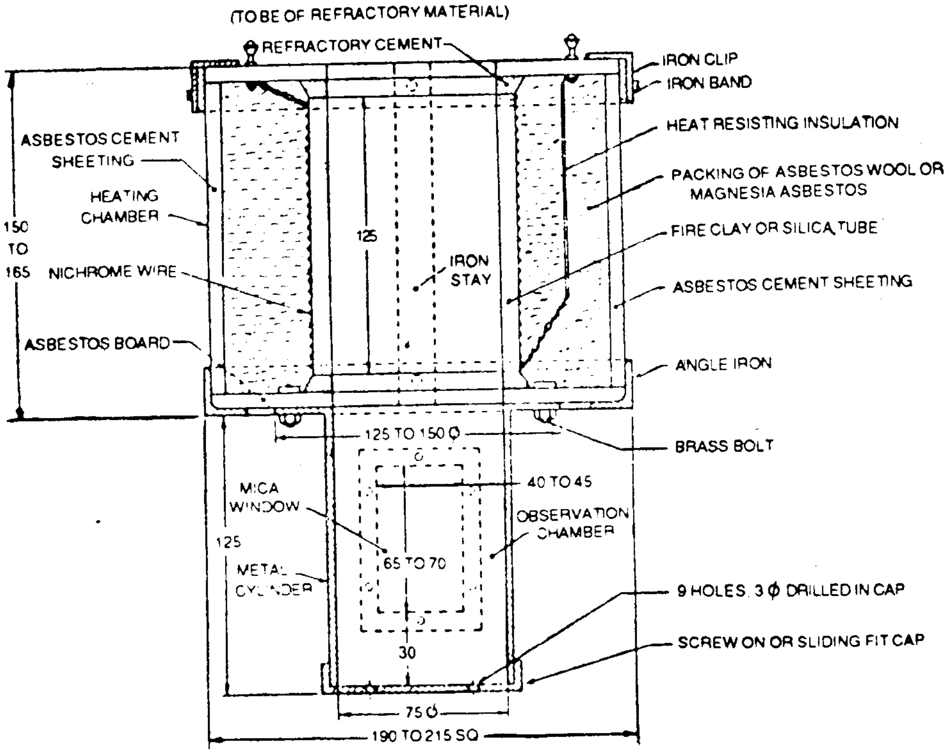
G-3 TEST FOR FLAMMABILITY

G-3.1 The temperature of the tube shall be raised to 300°C and the specimen shall be inserted in the tube. The temperature shall then be readjusted to 300°C within a period of 3 minutes, and this temperature shall be maintained until a period of 5 minutes has elapsed from the time of insertion of the specimen. During this period a conical cover at the top shall limit the opening to approximately 6.5 cm^2 while the air intake orifice at the bottom shall be open approximately 0.65 cm^2. At the end of the period of 5 minutes, the specimen shall be removed from the tube. The material shall not be deemed non-flammable if at any time during the test, the specimen flames or gives off flammable vapours in sufficient quantities to ignite at the pilot flame.



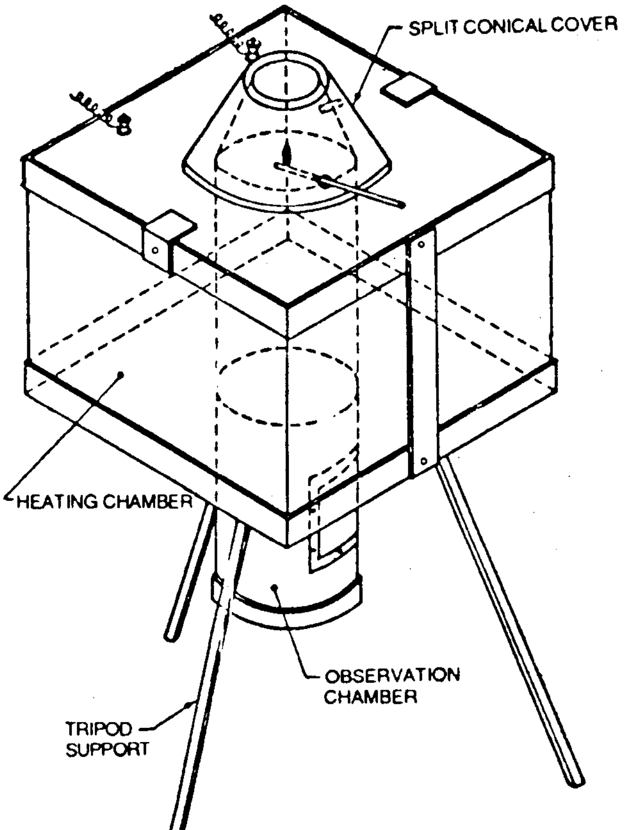
11A Details of Conical Cover

FIG. 11 APPARATUS FOR IGNITION TEST – *Continued*



SECTION OR OVEN

11B Details of Test Oven



11C Sketch of Assembled Apparatus

FIG. 11 APPARATUS FOR IGNITION TEST

ANNEX H

(*Clause* A-3.1)

SAMPLING PROCEDURE FOR ACCEPTANCE TESTS

H-1 LOT

H-1.1 In any consignment, all appliances of the same make, model and type, and manufactured under similar conditions of production shall be grouped together to constitute a lot.

H-2 SELECTION OF SAMPLE

H-2.1 The number of appliances to be selected from the lot shall depend upon the size of the lot and shall be in accordance with col 1 and 2 of Table 4.

H-2.1.1 These appliances shall be selected from the lot at random. In order to ensure the randomness of selection, procedures given in IS 4905 : 1968 may be followed.

H-3 NUMBER OF TESTS AND CRITERIA FOR CONFORMITY

H-3.1 The appliances selected at random according to col 1 and 2 of Table 4 shall be subjected to the acceptance tests. An appliance failing to satisfy any of the acceptance tests, shall be considered as defective. The lot shall be considered as conforming to the requirements if the number of defectives found in sample is less than or equal to the acceptance number (*see* col 4) and shall be rejected if it is greater than or equal to the first rejection number (*see* col 5). If the number of defective lies between the acceptance number and first rejection number, the second sample of the same size (*see* col 3) shall be chosen at random and tested. If the number of defectives found in the combined samples is greater than or equal to the second rejection number (*see* col 6), the lot shall be rejected, otherwise the lot shall be accepted.

Table 4 Sample Size and Criterion for Conformity

(*Clauses* H-2.1 *and* H-3.1)

Lot Size (1)	First Sample (2)	Second Sample (3)	Acceptance Number (4)	First Rejection Number (5)	Second Rejection Number (6)
Up to 50	5	5	0	2	2
51 to 100	8	8	0	2	2
101 to 300	13	13	0	2	2
301 to 500	20	20	0	2	3
501 and above	32	32	0	3	4

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